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The Capitalization of Real Property Taxes Levied on Farm Real Estate

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The capitalization of changes in property taxes levied on farm real estate is investigated. The per acre value of farm real estate in the United States is estimated as a function of the effective tax rate and as a function of three categories of independent variables which are related to agricultural productivity, farm size, and urban influence in a cross-section study. The effect of anticipated appreciation in farm real estate values is explored in estimating the extent of capitalization. The results of the study are consistent with the hypothesis that changes in property taxes are largely capitalized into farm property values.

Key words: farm property, taxes, capitalization, inflation hedge.

The local property tax has become a key political issue of the 1970s. There appears to be a growing political consensus throughout the United States to decrease the reliance on the local property tax in financing local schools and other local government services. There has been a concomitant national trend to reduce the effective rate of property taxes levied on farmland below that for other classes of real estate. During the past decade, pressure for special tax treatment for farmland has led to various forms of preferential taxation for farmland in about half the states.[1]

Little information is available concerning the potential effect of changes in property taxes levied on farm real estate. Despite the potentially redistributive effects of such tax changes, economists have given surprisingly little attention to the capitalization of property taxes levied on real farm property.

After briefly viewing the evidence, Netzer concludes that "empirical evidence on capitalization is most unsatisfactory" (1966, p. 24). Netzer supports this conclusion by citing the well-known study by Jensen which found strong evidence of capitalization of property taxes in farm real estate values in the United States during the period from 1919 to 1924 and contrasts these results with those from a more recent Michigan study by Daicoff which found little evidence of capitalization. Recent studies in Indiana (Schuh and Scharlach) and in North Carolina (Pasour) found that increases in effective property tax rates were associated with decreases in farm real estate values. These studies were concerned with property tax differentials within a given state. There appears to have been no recent study of the incidence of the property tax levied on farm real estate which has applicability to property tax differentials between states. The objectives of this study are to determine the extent to which property tax differentials between states are capitalized into farm real estate values and the effect of a change in property tax rate as a proportion of income by farm size.

An economic model is formulated to determine the effects of changes in real property tax rates on farm real estate values. The model is then estimated and the results used to determine the extent of capitalization of property taxes levied on farm real estate. The importance of anticipated appreciation in farm

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[1] Support for "present use value" taxation of farmland emanates from at least three sources. First, individual owners of farm real estate hope to reduce their tax burden. Second, some individuals desire to preserve prime agricultural land, especially in rapidly urbanizing areas. Third, other people support "use value" taxation as a way of preserving open space near urban areas.

real estate values is stressed in estimating the effect of a given change in real property taxes on farm real estate values. The regressivity of property tax differentials borne by owners of farm real estate is then estimated by determining the value of real farm property owned by income level in agriculture and by estimating the effect of a given tax decrease by income level.[2]

The Economic Model

Tax Capitalization

Taxes levied on unimproved land result in lower land values. In the classic Richardian case of land in perfectly inelastic supply, a tax is fully capitalized and merely serves to reduce land rent. Tax "shifting" is possible under competitive conditions, however, if the supply of land and improvements is not perfectly inelastic, i.e., if the quantity of improved land is reduced when the tax is imposed.

The supply of farm real estate is not likely to be perfectly inelastic. Farmland is similar to other capital investments in requiring initial development and subsequent maintenance.[3] These capital investments as well as investments in farm buildings (a component of farm real estate) will increase in response to price increases. However, such changes are likely to be small relative to the total quantity available. This implies a highly inelastic supply curve. It is hypothesized in this study that little tax shifting occurs or that property taxes are largely capitalized into farm property values.

The hypothesized demand and supply conditions for U.S. farm real estate are depicted in figure 1. The annual rental value before the tax is imposed is Or_0 when the demand and

[2] The incidence of a tax is said to be regressive if "the tax as a percentage of the incomes of those who bear the ultimate burden declines as income rises" (Netzer 1966, p. 5).

[3] The quantity of farmland is not fixed but can be increased by drainage or other forms of reclamation. In addition, improvements in the form of increased fertility, clearing, grading, etc. represent investments in reproducible capital which affect land values. "The argument is . . . then the interest like rent on such investments cannot be taken without checking future commitments for such purposes" (Jensen, p. 62).

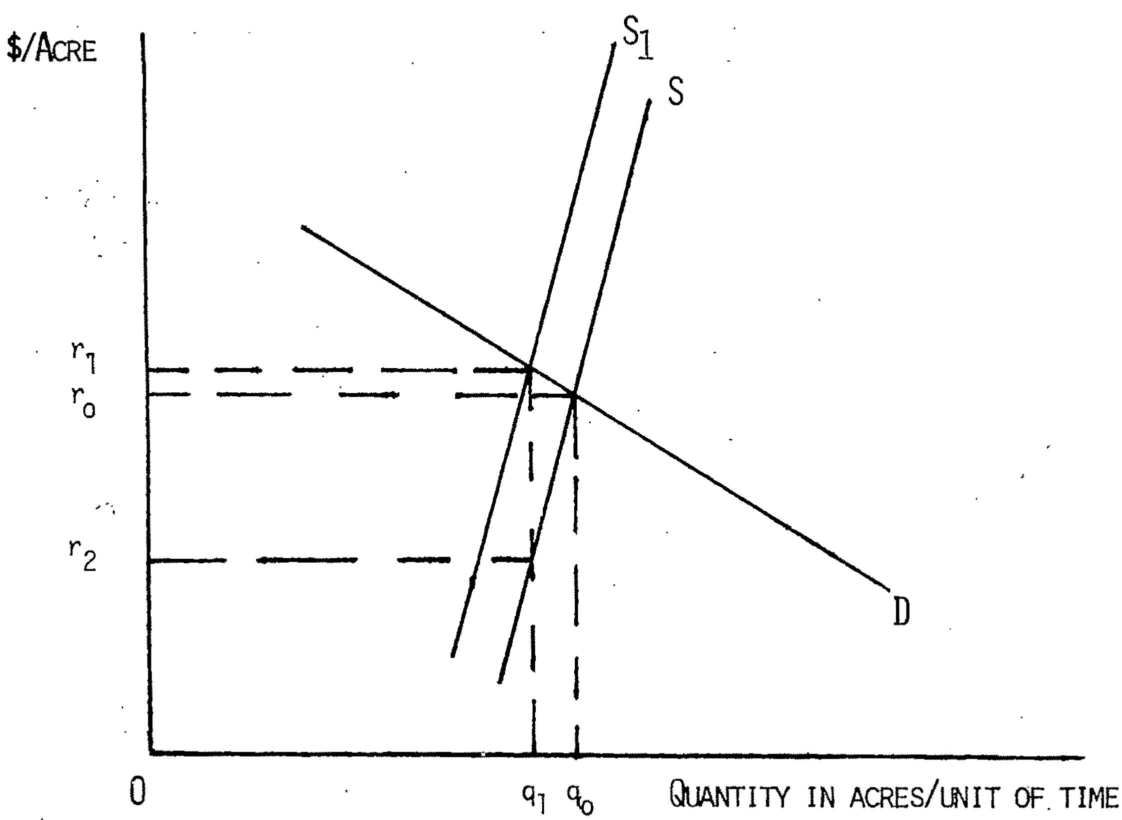

Figure 1. Hypothesized effect of a tax on farm real estate

supply of real farm property are designated by D and S, respectively. The rental value in the case of owner-operated land represents implicit rents on an annual basis. The market value of real estate is the capitalized value of these expected annual rents. When a property tax is levied, supply shifts from S to S_1 and the quantity decreases (or does not increase as rapidly as it might have) from Oq_0 to Oq_1. The annual rental value is increased slightly from Or_0 to Or_1 so that this portion of the tax is "shifted." The remaining portion of the tax (Or_0 less Or_2) is capitalized into lower property values. When the supply of farm real estate (improved land and buildings) is quite inelastic as hypothesized in figure 1, the major portion of the tax will be capitalized into lower property values.[4]

Variables and Data Sources

The value of farm real estate in 1969 was regressed on the tax rate for that year and a group of variables hypothesized to be associated with changes in the price of farm real estate. Three categories of explanatory variables related to agricultural productivity, farm size, and urban influence were included in the analysis. The dependent variable was the average value per acre of farmland and buildings by state.[5] These values were obtained from the 1969 *Census of Agriculture*. The average value ranged from \$42 per acre (New Mexico) to \$1,082 per acre (New Jersey).

The effective tax rate is the ratio between total taxes paid and the market value of the property contained in the tax base. In practice, it is difficult to compare effective rates between taxing jurisdictions because appraised tax values often deviate significantly from market values. This problem was minimized by using estimates of property taxes levied per \$100 of full market value of farm real estate (USDA 1971).[6] The effective tax rate ranged from \$0.25 (per \$100 of full market value) in Alabama to \$2.43 in Maine and Massachusetts. A negative sign was hypothesized for the property tax variable.

The value of an asset is the present value of its expected stream of net returns. Two variables were included to reflect differences in value arising from variation in agricultural productivity. The acreage of cropland (harvested) as a percentage of total farmland by state was included as an explanatory variable since cropland relative to other farmland has a higher value for agricultural purposes. The second agricultural productivity variable was the market value of crops and forestry produced in 1969 per acre of land in farms. This variable reflects differences in land values due to both allotted crops and soil productivity.[7] The data for these variables was taken from the 1969 *Census of Agriculture*. A positive sign was hypothesized for each agricultural productivity variable.

Average size of farm by state (in acres) was included as an explanatory variable since other studies of farm property values have shown an increase in average farm size to be associated with a decrease in average per acre value of farm real estate. This variable was hypothesized to have a negative sign.

Urban factors exert a great deal of influence on farm real estate prices, especially for property located near large urban areas. Two measures of urban influence were used and were hypothesized to have positive signs. Population per square mile provides an indication of the current level of economic development. Population per square mile varied from 3.4 in Wyoming to 953 in New Jersey. The percentage change in rural population gives an indication of the rate of economic growth.[8] The

[4] The proceeds of the tax must also be considered in determining the extent of capitalization. "It is possible that the so-called 'beneficial value' of public services, made possible by high taxes, will operate to increase the rent and thus make the capitalization process appear to be less sensitive to changes in net return after taxes" (Jensen, p. 73).

[5] About 80% of the land in the United States consists of forests and farmland. Only about 8% of the land is used for urban purposes including roads (USDA 1972).

[6] The problem of use-value taxation for agricultural land poses a problem although the implications for this study aren't clear. In some cases, there are no restrictions on future land use associated with preferential taxation policies. In other cases, a "roll back" tax is levied when land qualifying for and receiving use-value tax status passes into nonqualifying uses. A preferential taxation policy (regardless of the rollback feature) would not affect the market value of qualifying farm property as long as the opportunity cost of the land is highest in a nonagricultural use. In this case, a reduction in the average effective tax rate due to use-value taxation would be expected to increase the value of the property for agricultural purposes but not affect the market value. Thus, some part of the variation in effective tax rates observed in the study would have no effect on market values of farm property. Consequently, use-value taxation may bias the coefficient of the tax rate variable. Changes in the effective tax rate due to recent use-value taxation, however, have probably been quantitatively much less important that the de facto preferential tax treatment for farm property which existed before the differential assessment laws were passed.

[7] Farm real estate values might also vary on a per acre basis due to a different mix of crop and livestock enterprises between states. A variable including other products sold per acre of land in farms was tested in preliminary tests of the model. It had no significant effect and was dropped from the analysis.

[8] The change in rural population was used as the measure of population change. Rural population as defined by the census

variables relating to urban influences were computed from the 1970 *Census of Population.*

In summary, the following economic model was formulated:

$$(1) \quad Y = f(X_1, X_2, X_3, X_4, X_5, X_6),$$

where Y = average per acre value of farm real estate in the United States, by state, 1969; X_1 = property taxes levied per \$100 of full market value of farm real estate in 1969, by state; X_2 = percentage change in rural population from 1960 to 1970, by state; X_3 = population per square mile in 1970, by state; X_4 = average size of farm in acres, by state, 1969; X_5 = cropland harvested as a percent of total acreage of farm real estate, by state, 1969; and X_6 = average market value of crops and forestry per acre of land in farms, by state, 1969.

Empirical Results

The economic model was estimated by ordinary least-squares regression procedures using cross-section data from the forty-eight contiguous states. The following equation was estimated:

$$(2) \quad Y = 104.82 - \underset{(4.49)}{63.67X_1} + \underset{(4.69)}{4.33X_2} + \underset{(5.38)}{0.34X_3} - \underset{(1.24)}{0.01X_4} + \underset{(5.65)}{3.33X_5} + \underset{(8.42)}{3.81X_6}$$

$$R^2 = 0.95$$

All variables were used in linear form. The t-value for each regression coefficient is shown directly below the coefficient. The regression coefficient of each variable has the hypothesized sign. The coefficients of all variables with the exception of X_4 are significant at the 0.01 level. These variables explain 95% of the variation between states in the average per acre value of farm real estate.

Higher values of the urban influence variables, X_2 and X_3, were associated with higher farm real estate values. The coefficient for X_2 indicates that immigration to rural areas bids up farm property values. A 10% difference in rural population change (positive) during the 1960–70 period, other factors constant, was associated with \$43.30 per acre higher land values. The coefficient of X_3 indicates that each additional ten persons per square mile were associated with \$3.40 per acre higher farm real estate values.

The coefficient of the farm size variable, X_4, indicates that a variation in average farm size, *ceteris paribus,* had no appreciable effect on the price of real farm property. The coefficient, which has the hypothesized sign, is significant at the 0.12 level. However, even if one accepts this level of statistical significance, the magnitude of the coefficient supports the conclusion that changes in farm size, at least in terms of state averages, had no appreciable effect on farm real estate values.[9]

The coefficients of the productivity variables, X_5 and X_6, have positive signs as hypothesized. The coefficient for X_5 indicates that a state with 10% more harvested cropland as a percentage of total farmland, *ceteris paribus,* has \$33.00 per acre higher farm property values. The coefficient for X_6 indicates that an increase of \$10.00 per acre in average annual market value of crops and forestry was associated with \$38.10 per acre higher average farm real estate values.

Capitalization of Property Taxes

The statistically significant coefficient for X_1 indicates that property tax differentials do affect farm real estate values. The coefficient for X_1 suggests that an increase in tax rate of \$0.10 per \$100 of full market value of real farm property was associated with a decrease of \$6.37 per acre in farm real estate price. This result by itself, however, does not indicate the extent of capitalization of a change in the rate of property taxes levied on farm real estate. The effect of an increase in property taxes on the value of farm real estate when the tax is fully capitalized must be known to determine the extent of capitalization implied by equation (2).

If both rent and the discount rate are expected to be the same each year in perpetuity and the interest rate is known, the capitalization formula, $V = R/i$ can be used to determine the annual rent per acre necessary to justify a price of \$288 per acre, the average value of farm real estate in the study. Here V is the capital value, R is the annual net income per acre, and i is the expected market rate of in-

includes all people living in rural areas as well as towns and villages having fewer than 2,500 people.

[9] The coefficient of X_4 indicates that a one acre increase in average farm size was associated with a price decrease of \$0.01 per acre.

terest. The cost of carrying land each year ($V \cdot i$) is just covered by the annual rent (R). This formulation assumes that the annual property tax rate (t) is zero or that R is net of taxes. For any property tax rate greater than zero, the discount factor then includes both the opportunity rate of return on capital and the tax rate (expressed as a percentage of V), that is, $V = I/(i+t)$ where I represents annual net income per acre before taxes.[10] This modification in the capitalization formula indicates that annual rent before taxes must be higher when property taxes are paid to cover the increased cost of carrying land each year [$V(i+t)$].

Annual Returns Not Constant

The capitalization procedure just described assumes that the income from land will be the same each year. However, expected income is not likely to be constant over time since the annual return from farm real estate has been increasing due both to increases in cash rent and to appreciation in farm property values. For example, the average per acre value of farm real estate in the United States increased 21% during the year ending November 1, 1973 and another 21% during the year ending November 21, 1974 (USDA 1974, 1975). Although these increases were unusually large, farm real estate prices have been appreciating at a substantial rate during most of the post-World War II period. The index value (1967 = 100) of average value per acre of farm real estate in the United States increased from 37 in 1947 to 141 in 1972 (USDA 1973b, p. 4). This represents a compounded rate of appreciation of farm real estate on a per acre basis of about 5.5% per year.

During most of the post-World War II period, farm real estate values have increased at a rate faster than that of cash rent or farm income.[11] The net rent of farms rented for cash increased in nominal terms during the 1960s, for example, but decreased as a percentage of value of farm real estate (Reinsel and Johnson). During the period from 1961 to 1968, average net cash rent per acre of farms rented for cash in the United States increased from \$5.41 to \$6.94 (Reinsel and Johnson, p. 23).[12] This represents a compounded rate of appreciation of about 3.5% per year. The fact that cash rents increased more slowly than farm property values may not represent an actual decrease in the rate of return, however, since it does not consider capital gains in the form of appreciation in property values as a de facto component of annual returns.

The capitalization formula discussed above must be adjusted when annual returns are expected to vary over time. There is no consensus concerning the appropriate measure of income in the case of appreciating assets. Simons defines income (as do most economists) in terms of potential consumption as "the result obtained by adding consumption during the period to 'wealth' at the end of the period and then subtracting 'wealth' at the beginning" (p. 50), that is, income in any period is the maximum value which an individual can consume during that period and still be as well off at the end of the period as at the beginning. Expected appreciation of any asset (capital gains) serves to increase wealth and clearly represents expected income according to the Simons definition.

Fisher, on the other hand, defines income in terms of actual consumption and holds that capital gains "are merely capitalization of future income. They are never present income" (p. 25).[13] Regardless of whether capital gains are defined as present income, however, there is little doubt that investors consider expected appreciation to be a component of the anticipated return of rent from land when comparing investments in land with other investment alternatives.

The market value of land and other property

[10] When $t > 0$, the capitalization formula is adjusted for taxes as follows:

$$V = \frac{I - tV}{i}$$

$$V(i+t) = I$$

$$V = \frac{I}{i+t},$$

where V = value of asset after tax and i, t, and I are as previously defined.

[11] A number of studies have been conducted in the United States to explain the apparent decreasing rate of return earned on investments in farm real estate during the post-World War II period. See, for example, the studies by Chryst, Grove, Scofield, and Crowley. Boyne also investigated the effect of changes in purchasing power of farm real estate and other assets on the real wealth position of farm operators.

[12] Farm real estate which is cash rented may not be representative of all farm property. In some areas, pasture and farm buildings are the main forms of farm real estate rented. Also, woodland, though included in farm real estate values, is not likely to be cash rented.

[13] Interest accrued on savings, for example, represents not income but only an accretion of capital in Fisher's view. Only if the interest is actually paid out does it represent income. "The income consists in the event of such off-giving, the yielding or separation . . . Income may be *invested* and thus transformed into capital; or capital may be *spent* and so transformed into income" (pp. 26–27).

(risk level given) depends on the annual returns expected and the discount rate by which the returns are discounted. The annual return or rent from land in any year may be viewed as consisting of two components—cash rent and current appreciation (implicit rent). The capitalization formula is adjusted below to reflect expected changes in annual returns (mainly in the form of implicit rents) over time.

Appreciation in Farm Property Values

Assume that a tract of land yields a yearly income above current costs (including taxes) (R) that grows by $g\%$ each year.[14] In this case, the capitalization formula is adjusted[15] so that

$$V_0 = \frac{R_0}{i-g} \qquad (\text{for } g < i), \tag{3}$$

where V_0 = present capital value, R_0 = initial level of annual rent (or income),[16] g = rate of growth of income each year, and i = market interest rate.

This result indicates that the expected rate of growth in income each year should be subtracted from the market interest rate in discounting the annual income to obtain the present value of an asset. In this model where income is expected to increase by $g\%$ annually, the cost of carrying land each year at the price V is just covered by the sum of annual rent at the beginning of the year plus current appreciation, that is,

$$V_0 \cdot i = R_0 + V_0 \cdot g, \tag{4}$$

where V_0 = value at beginning of year 1, $V_0 \cdot i$ = annual carrying cost of land, and i, R_0 and g are as previously defined.

In this case, annual income at the initial income level (R_0) is too little to cover the carrying costs ($V_0 \cdot i$). The annual deficit is $V_0 \cdot g$ which is the annual appreciation in the value of V_0. Furthermore, annual income increasing at $g\%$ per year is equivalent to an increase of $g\%$ per year in the value of the asset (V). Conversely, V increasing at $g\%$, implies that annual rent is increasing at $g\%$ where rent is defined to include both cash rents and implicit rents.[17]

Equations (3) and (4) hold for the case where the rate of appreciation in property values is less than the rate of interest. As indicated above, farm real estate values increased more than 20% during both 1973 and 1974. Thus, the rate of appreciation in farm property values exceeded the rate of interest during this period. However, it can safely be predicted that this phenomenon (where $g > i$) will not persist over time. If the rate of appreciation of real property was expected to exceed the interest rate indefinitely, the capital value of the asset would be infinitely large. Land ownership would be profitable under these conditions regardless of the amount of current cash returns.

In reality, there is no reason (other than transactions costs) for the expected rate of appreciation of farm property (g) to exceed the interest rate (i). Prospective investors anticipating a larger rate of return than could be obtained on investments of a similar risk would bid up the price of farm real estate to the level where the rate of return is comparable to that of other investments. There is no reason for the expected net rate of return to be higher for investments in real estate relative to other investments of a similar risk.

Farm property during much of the period since World War II has been an effective hedge against inflation. When farm real estate

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[14] Gaffney refers to this case in which annual rent appreciates at a constant rate as a "perpetual appreciation" model (1970, p. 415).

[15] This result is obtained by summing a geometric progression (Gaffney 1970, p. 415).

[16] R may be composed of cash rent, implicit rent in the form of current appreciation in V, or some combination of cash rent and implicit rent. Crowley adjusts the capitalization formula to permit net cash rents and market value of land to appreciate at different rates. The approach taken here, on the other hand, is to consider both cash rent and implicit rent due to capital appreciation as the annual income which must be capitalized to obtain the market value of farm property.

[17] $V_0 = \frac{R}{i-g}$ = value at beginning of year; $V_1 = \frac{R(1+g)}{i-g}$ or value of V_0 compounded at $(1+g)$ is value at end of year. The appreciation during the year is

$$\begin{aligned} V_1 - V_0 &= \frac{R(1+g)}{i-g} - \frac{R}{i-g} \\ &= \frac{R(1+g)-R}{i-g} = \frac{Rg}{i-g} \\ &= V_0 \cdot g \text{ since } V_0 = \frac{R}{i-g}. \end{aligned}$$

The percentage increase in V_0 is represented by g which is $\frac{V_1 - V_0}{V_0}$, that is, income increasing at $g\%$ will result in an increase of $g\%$ per year in the value of the asset. It also follows that if V is increasing at $g\%$, the annual rent will increase at $g\%$ where rent is defined to include cash rents and implicit rents. $V_0 = \frac{R}{i-g}$ = value at beginning of year, and $V_0 = (1+g) = \frac{R(1+g)}{i-g} = V_1$ = value at end of year.

prices in the United States are analyzed for a longer period of time, however, there is much more uncertainty about the effectiveness of farm property as a hedge against inflation. Mistakes (in an ex post sense) are made by investors in land just as they are by investors in other assets. Farm real estate prices in the U.S., for example, averaged \$69 per acre in 1920. The typical investor in farm real estate at that time would have seen his investment decrease in value over a long period of time. It was thirty-one years later, in 1951, before nominal farm real estate prices for the U.S. as a whole were as high on the average as they were in 1920.

Although farm property values in 1920 were unusually high for that era, farm property is shown to be an uncertain hedge against inflation during a long period of time using the popular 1910–14 base period. Schultz, in analyzing the role of land in economic growth, found that the price of farm real estate per acre (with structures removed) decreased about one-third relative to farm product prices between 1910–14 and 1956. Farm product prices decreased about 15% relative to the consumer price index during the same period. Thus, farmland prices during this period were not an effective hedge against inflation.

Effect of Taxes

What will be the effect of an increase in farm property taxes when property values are appreciating? Taxes increase total carrying cost of land which may be shown as:

$$(5) \qquad V_0 \cdot i + V_0 \cdot t = I_0 + V_0 \cdot g.$$

The cost of carrying land each year at the price V_0 is just covered by the sum of income plus appreciation.[18] When annual income is appreciating at a constant rate g and the annual tax rate is t, equation (5) between carrying costs and income may be solved for V_0 to obtain

$$(6) \qquad V_0 = \frac{I_0}{i+t-g},$$

where V_0 represents value at beginning of year after taxes and all other terms are as previously defined. Thus, the effect of an increase in the tax rate so long as $g - t$ is positive will be to slow the rate of appreciation in property values, not to decrease the absolute level of property values.

Full Capitalization of a Tax Increase

Equation (6) indicates that market value is equal to the annual net return before taxes discounted by the sum of the expected interest and tax rates less the expected rate of appreciation. When annual income net of taxes is appreciating at a constant rate g, equation (3) may be rewritten as

$$(7) \qquad \frac{R_0}{V_0} = i - g.$$

Data on the appropriate discount rate $(i-g)$ to use in capitalizing net rent may be inferred from market values of net rent (R) and farm property (V). Net rent as a percentage of farm real estate value was not available for all farms but was available for farms rented for cash. The R_0/V_0 ratio for these farms ranged from 3.5 to 4.6 and averaged 4.1% during the 1960s (Reinsel and Johnson).[19] The average net rental rate on farms rented for cash, despite some limitations, gives an indication of the relationship between land earnings and market prices.[20] The average relationship between land earnings and market prices, 4.1%, is used below to estimate the effect of an increase in the tax rate which is assumed to be fully capitalized.

Equation (7) indicates that the discount factor appropriate in capitalizing net rents $(i-g)$ is equal to the ratio of expected rent to market value. Given the assumed ratio of net rent to market value,

$$(8) \qquad \frac{R}{V} = i - g = 0.041,$$

where i and g are as defined previously, R represents net rent on an annual basis and V is market value.

[18] An ad valorem tax levied on the basis of a percentage of value, e.g., \$2/\$100 market value, is equivalent to an annual decrease in V_0 at the rate of 2%. Thus, it is appropriate to specify equation (5) as written or as follows:

$$V_0 \cdot i = I_0 + V_0\,(g-t).$$

Hence, the tax rate may be subtracted from g in determining the net rate of appreciation. For example, if an acre of land appreciates at 5% of the market value per year and is taxed at 2% of market value, this may be viewed as a net rate of appreciation of 3% per year.

[19] Net rent was computed by subtracting landlord expenditures from gross rent. Landlord expenditures included insurance, depreciation, repairs, and property taxes.

[20] "Cash rented farms may not be typical of all farms in many areas. In addition, rates may differ considerably between crop and livestock enterprise. Also, family relationships of owner and tenant frequently influence rental rates" (Reinsel and Johnson, p. 12).

Equation (8) may be solved to determine the annual net rent consistent with the observed market value and discount rate. The average value of farm real estate was \$288 per acre in 1969. Substituting in equation (8) yields

$$\text{(9)} \qquad \frac{R}{\$288} = 0.041 \text{ or, } R = \$11.81,$$

that is, real farm property must yield an annual net rent of \$11.81 per acre to be consistent with the value of \$288 per acre given the prevailing interest, tax, and appreciation rates. A tax increase of \$0.10 per \$100 of full market value increases the effective discount rate and, fully capitalized, would reduce the per acre value (after tax) of farm real estate as shown:

$$\text{(10)} \qquad V = \frac{\$11.81}{0.041 + 0.001} = \$281.19.$$

Full capitalization of a \$0.10 increase in tax rate (as from \$1.12 to \$1.22) implies a reduction in value of \$6.81 per acre (from \$288 to \$281.19).[21] The coefficient of X_1 in equation (2) indicates that a tax rate increase of \$0.10 per \$100 was associated with a decrease of \$6.37 per acre in the market value of farm real estate. Thus, if full capitalization of a \$0.10 increase in tax rate implies a reduction in value of \$6.81 per acre, the coefficient of X_1 in equation (2) is consistent with the hypothesis that any change in property taxes is largely capitalized into property values.

Regressiveness of Property Taxes Levied on Farm Property

The relationship between real farm property values and tax rates estimated above and the above calculations suggest that property tax differentials are essentially fully capitalized. The benefit of a tax decrease to owners of farm property, assumed to be fully capitalized, is estimated in the following analysis for 1969. The analysis considers only the benefit of the tax decrease to farm operators owning farm real estate. It does not attempt to measure the benefits for nonfarm owners of farm real estate.

The value of land and buildings owned by farm operators is not available directly by income class. However, data are available on both average income and average value of land and buildings owned per farm when classified by value of farm sales. Average income per farm from all sources instead of farm income (income from only farm sources) was used in comparing farm property taxes with income by income level. The regressivity of property taxes is conventionally taken to be important mainly from the standpoint of welfare (as opposed to resource allocation). In this context, \$1 of income has the same effect on welfare regardless of source.

The estimated effect of a reduction in property tax rates on real farm property as a proportion of farm income by farm size was determined for the United States as follows. Farms were classified by value of gross farm sales using U.S. Department of Agriculture data for 1969. Farm sales are positively correlated with farm size in acres for all levels of output. Total income is positively correlated with the value of land and buildings owned per farm except for the smallest category of farms, farms with sales of less than \$2,500 per year (U.S. Bureau of the Census 1972; USDA 1973a).[22]

The amount of property taxes for a tax decrease of \$0.20 per \$100 value under average circumstances was computed for each farm size category. The amount of the tax capitalized into higher property values was then compared with income by size of farm. The capitalized tax as a percentage of income for farm sales categories (from small to large) were as follows: 1.19, 1.21, 1.30, 1.19, 1.15. Since the value of land and buildings is strongly correlated with total income, the tax reduction accruing to the operator as a percent of income was about constant but slightly regressive for farms having sales totalling more than \$20,000 per year.

Implications

The results of this study illustrate the problems in determining the burden of the property tax levied on real farm property. The regressiveness of the property tax depends both on the extent of capitalization and on the amount

[21] The average tax rate in the study was \$1.12 per \$100 of market value.

[22] USDA farm sales categories are as follows: less than \$2,500; \$2,500 to \$4,999; \$5,000 to \$9,999; \$10,000 to \$19,999; \$20,000 to \$39,999; \$40,000 and over. Farms with sales of less than \$2,500 per year were considered to be special cases and this category was omitted from the analysis. Average income from all sources is larger for this category than for the next two larger farm sales categories due to larger amounts of income from nonfarm sources. Off-farm income comprised 87% of total income for farms with sales of less than \$2,500 per year.

of taxes paid by income class. It is difficult to determine empirically the extent of capitalization since actual capitalization must be compared with full capitalization for a given tax change which requires estimates of expected rent and discount rates over time.

Although the results of this study indicate little evidence of property tax regressiveness, several caveats are in order. First, there is likely to be a great deal of variation in the burden of property taxes for any given income level. The ratio of real property taxes paid to farm income is likely to vary both by region and by type of farm. For example, operators of Class 1 cash-grain farms in North Carolina owned 700 acres of land per farm in 1969.[23] Operators of Class 1 poultry farms, on the other hand, owned on the average only 113 acres of land per farm (U.S. Department of Commerce 1972). Consequently, the average value of land and buildings owned was much higher on cash-grain farms relative to poultry farms ($222,000 versus $51,000).

Second, there is likely to be a difference in the ratio of value of buildings to land for different income classes. One might expect this ratio to be higher on smaller farms. If there is more capitalization of taxes levied on farm land (relative to building value), then the tax may be more regressive than indicated in this study.

Third, the empirical relationship estimated in this study indicates the effect of property tax differentials on property values, that is, the empirical results indicate the effect of the differential portion of tax rates between states on farm property values. These results do not indicate the extent to which the portion of the tax which is common to all states is capitalized into lower property values.

Fourth, there is a difference between the short-run and long-run effects of a decrease in tax rate. Tax capitalization assumes an adjustment period long enough for market conditions to respond to the effect of the tax. In the long run, a given decrease in tax rate will decrease the amount of property taxes paid by less than the decrease in the tax rate because property values increase as a result of a tax decrease.[24] This conclusion assumes a length of adjustment period sufficiently long for property to be reappraised in response to the increase in value arising from the decrease in tax rate. Taxes would decrease in proportion to the decrease in tax rate until reappraisal occurs.

Fifth, the effect of a change in property tax rate may differ from farmer to farmer at any income level depending upon the relative amounts of real estate owned vis à vis other capital inputs, the importance of land (as opposed to buildings) in farm real estate values, and the proportion of all farm property operated which is owned.

In conclusion, this study is consistent with the generally accepted hypothesis that changes in property taxes are largely capitalized into farm real estate values. However, the tax burden as a proportion of income is likely to vary for farm operators in any given income level. It may well be as Netzer argues "that theoretical analysis of the existing partial tax is so complex that there is no substitute for place-specific empirical work on property tax incidence" (1973, p. 515).

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[23] Class 1 farms are defined by the agricultural census as those having $40,000 or more of product sales.

[24] Use-value tax preferences which require back payment of property taxes when land use changes from agricultural to other uses must also be considered. The presence of a rollback feature means that the de facto decrease is likely to be smaller than the nominal decrease in tax rate.

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Transfer of Development Rights: An Analysis of a New Land Use Policy Tool

Richard L. Barrows and Bruce A. Prenguber

The issues in establishing and administering a transfer of development rights program are discussed, and an hypothetical program is empirically analyzed. In the case study, administrative assignment of development rights and definition of development unit significantly affected the distribution of program costs. Full compensation to restricted landowners would have required widely fluctuating development right prices. Initial cost burdens varied with type of development as well as within development categories. Timing of development right supply and demand may create problems in the market. Although the TDR concept is promising, many practical difficulties remain.

Key words: land use, transfer of development rights, planning, zoning.

The land development process is characterized by individuals responding to market signals such as housing demand or prices, mortgage rates, construction costs, and other incentives in the market economy. Collective action to regulate land development has long been a part of U.S. public policy—an implicit recognition that unrestricted private land development activity does not lead to socially optimal land use patterns (Bosselman, Callies, and Banta, pp. 51–130). Yet, many feel that the policy tools for guiding land development are not adequate (Babcock, pp. 138–52). The major policy tool for guiding the development of open land has been zoning, and the major weakness of zoning policy is the "windfall-wipeout" dilemma (Hagman). Landowners not zoned for development may suffer "wipe-out losses" by being unable to fully develop their property and have strong economic incentives to change the zoning and thwart the community's land use plan. Local officials may bow to such political pressure, but even if authorities would wish to maintain the non-development zoning, they are faced with possible lawsuits arguing that the low density or open space zoning has such drastic effects on the value of the property as to constitute a "taking" under the Fifth Amendment (Babcock, Large).

Transfer of development rights (TDR) is a proposed land use policy tool designed to overcome the windfall-wipeout dilemma and the perverse economic incentives created by traditional zoning. Under TDR, the local zoning body would identify zones for development and preservation.[1] Restricted landowners would be assigned development rights units (DR), and development zone landowners would be prohibited from developing beyond some specified density unless they purchase DR from restricted landowners in the preservation zone.[2] Thus, it is argued that preserva-

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[1] The preservation zone may not prohibit all development but is clearly an open-space zone, such as farmland. The development zone may allow only residences, as in a New Jersey proposal, or may also allow industrial-commercial development, as in a Maryland proposal.

[2] This paper will focus on TDR programs which transfer DR through a private market, the alternative receiving the most serious consideration (Chavooshian and Norman, Rose). Alternatively, government may participate in the market by condemning all DR and acting as a "DR bank," similar to a land bank, or by participating with the private sector in DR purchase or sale. If government acts as a "DR bank," the public could capture part of the rents in the land development process through appreciation of publicly held DR and thus capture part of the "unearned increment" in land value which accrues to the landowner because of community growth or public investments. Public participation in the DR market would also overcome problems of timing of DR supply. The administrative problems and the incidence of cost would not be altered by government intervention, and the question of "fair" compensation would remain. A government DR bank would necessitate large expenditures for initial DR acquisi-

tion zone landowners would be compensated for their "wipeout losses" by sale of DR to development zone landowners wishing to develop.

Proponents argue that TDR is a major breakthrough in land use policy because it overcomes the windfall-wipeout dilemma. The theoretical advantages of the TDR concept have been stated often (Chavooshian and Norman; Costonis; Rose), but the practical problems of initiating and administering TDR programs have not been adequately researched. In the next section, the theoretical aspects of TDR are discussed and potential problems identified. Then, the operation of a specific TDR program around highway interchanges is analyzed in order to evaluate some of the potential problems of TDR.

Theoretical Analysis of TDR

Descriptions of proposed TDR programs can be found in the literature and will not be duplicated here. Rather, this discussion will focus on those key elements of a private market TDR program which could ultimately determine its success or failure. These key elements involve the DR market, the distribution of costs of a TDR program, potential changes in the distribution of private and public rights in private land, and issues in TDR program administration.

The Development Rights Market

TDR programs separate a "development right" from the bundle of property rights which could be transferred through a market. Obviously, the DR market must function in a reasonable manner in order for restricted owners to be compensated.

The demand side of the DR market may be quite unpredictable. A highly sophisticated planning agency will be required not only to produce the land use plan but also to accurately forecast development demand in the area. A strong demand for development in the development zone will be required to ensure adequate DR demand so that DR will be transferred and restricted owners compensated. A TDR program in a small area such as a highway interchange could ensure strong DR demand, but only limited open space areas could be preserved and developers may be able to avoid DR purchase by building in nearby areas not included in the TDR program. A larger program, e.g., on a county scale, would be more difficult to administer due to difficulty in predicting exact location and strength of development demand. In addition, a large preservation area implies that many DR of substantial aggregate value must be purchased to ensure compensation, but DR demand may not be sufficient unless massive urbanization is underway.[3]

DR demand may also be influenced by the fact that initiation of a TDR program would generally be tied to zoning.[4] Some proposals call for TDR development zones to be identical to areas already zoned for development under current zoning (Chavooshian and Norman, p. 12). This could render TDR ineffectual since in many communities, more land is zoned for development than will ever be built up. If this zoning is used as a basis for TDR, development may occur far into the future at low density levels without purchase of DR and compensation to restricted landowners. Alternatively, existing development areas may be downzoned to ensure that anticipated development results in purchase of DR. This alternative would face intense political pressure from landowners with economic incentives to avoid downzoning and might lock the TDR program into existing zoning patterns. Assuming these difficulties were overcome, the amount of downzoning would have to be carefully synchronized with anticipated development (and DR) demand in order to ensure compensation to restricted landowners.

In addition to the uncertainties of DR demand, the supply of DR that will be made available at particular prices cannot easily be predicted. If there are many holders of DR, each with his own reservation price, a positively sloped DR supply curve should result. A DR owner may calculate his reservation price according to whether he feels his land could have been developed and what compensation he desires for the lost development opportunity. Alternatively, DR holders may simply base their decisions to sell DR on their analysis of DR supply-demand outlook and their individual liquidity or investment

tion and might be viewed by some as excessive interference in the land development process.

[3] If DR demand is not sufficient in the large area, it may be argued that restricted landowners could not have developed their property anyway, and no compensation is required.

[4] An exception is the Fairfax County, Virginia plan which would substitute a TDR program for zoning (Moore).

portfolio position, and treat any loss of development opportunity as a "sunk cost" which is not relevant for calculating reservation price. In either case, the DR supply curve will be difficult to estimate in advance.

The DR supply may be affected by the size of the preservation zone. A small preservation area may be required in order to ensure strong DR demand, but a few landowners may own much of the acreage in the preservation zone, particularly if the zone is agricultural land, wetlands, or other natural areas. A near monopoly in DR by a few owners could result in less development and higher prices for DR than would prevail in a competitive DR market.

A final, practical problem in DR supply may arise from restricted owners' uncertainties about a new program such as TDR. Owners of DR may decide to hold their DR, waiting to see if the program will actually work. On the other hand, illiquid or low income DR holders may be tempted to sell their DR immediately to those who might wish to speculate in the new DR market.[5] In conclusion, the uncertainties of market actions by DR holders may not permit the assumption that DR supply will be a continuous positively sloped curve.

An additional problem in the DR market may be the timing of demand and supply. While there are timing problems in most land development markets (and in most markets where buyer and seller negotiate directly on price), the requirements for purchase of land and DR may exacerbate existing problems of land development timing. The time pattern of development may be altered, as the highway interchange analysis will suggest.

Distributional Issues

In theory, the DR market will redistribute economic rents generated in the development process and may affect the costs of the developer or the final consumer of the development product. In addition, TDR programs may indirectly affect the future distribution of rights in land between the landowner and the public. These distributional issues will be discussed in more detail.

The costs of TDR could fall on several groups. Restricted landowners may not be fully compensated for the lost opportunity to develop, but if all DR are sold each restricted landowner will capture some of the pure rents in the development process. TDR may ensure a more even distribution of these rents as compared to unrestricted development in which not all landowners may have been able to develop their property. The purchase of DR may raise initial costs (land and DR) for developers. However, the cost may be partially or fully offset if the developer is able to offer lower prices to landowners in the development district.[6] Assuming that the developer was unable to pass the DR cost to the development district landowner, he may be able to include all or part of the added cost in the price of the house or commercial building, depending on the elasticity of demand for development. So, the cost of TDR may be borne partially by restricted landowners, development landowners, developers, or final consumers. The extent to which each group shares in the cost depends on the market power of DR holders and development district landowners, the elasticity and strength of demand in the development district, and the bargaining skills and strategies of all parties involved.

A TDR program is designed to compensate landowners who are restricted from development under a legally adopted community land use plan. The immediate question arises: What is fair compensation? The courts have ruled that the full loss to the restricted landowner, i.e., the difference between the property's use value and development value, need not be compensated (Bosselman, Callies, and Banta; Large). A wide range of views of what constitutes "fair compensation" may be found in most communities. Restricted landowners may feel that full compensation is necessary, while others may argue that very little compensation is needed. Under TDR, compensation of restricted landowners is left to what might be a highly unpredictable and unstable market, and the compensation that results may meet neither the court's nor the community's definition of "fair" compensation.

Finally, a TDR program may arrest the evolution in property and zoning law involving

[5] Early sale by low income or illiquid individuals would be further encouraged if DR are subject to the property tax, which would increase holding costs. For a discussion of DR taxation, see Rose (pp. 661–62).

[6] The developer may not be able to pass on DR costs by lowering the price paid for development district land. It is possible that land prices in the development zone may increase under TDR if landowners exploit their monopoly position created by the TDR program.

basic changes in the balance of public and private rights in private land (Large). An "unearned increment" may be defined as the difference between use value and development value of land which accrues to the landowner because of community growth or the actions of public agencies. Under TDR, the unearned increment becomes an explicit property right for which the property owner is entitled to seek compensation, even though the compensation is market-determined. Recent court cases have, in effect, been defining more and more of the unearned increment to be capable of governmental denial without compensation (Large). A TDR program could arrest this gradual evolution in the balance of private versus public rights in privately owned land. Thus, while overcoming the problems of uncompensated restrictions and the perverse economic incentives created by zoning, TDR could halt an evolutionary process in the courts which ultimately could eliminate the problem TDR seeks to solve. In addition, the evolution of the private-public balance in private property may help solve many land use problems far beyond those addressed by a TDR program.

Program Administration

There are several critical requirements for successful TDR program administration. A highly skilled planning agency is required not only to forecast development demand but also to define the density permitted in the development zone without DR purchase and the rate at which DR may be converted into additional density for different types of development. Density could be defined in several ways, but a method must be devised to compare densities for different types of development. For example, how many DR should be required for a four-unit apartment building versus a single-family house versus a restaurant if each is built on a one-acre lot? The assignment of these relative density weights will determine the number of DR each type of development must purchase and will influence the distribution of costs of the TDR program, as the analysis of the highway interchange TDR program will illustrate.

As development proceeds, there may be a need to modify the original TDR program to allow for greater development densities which could be accomplished by upzoning or issuing additional DR.[7] Upzoning would decrease DR demand by allowing greater densities without DR purchase, and hence the price of DR would fall. All DR holders would be adversely affected by the price decrease.

Issuance of additional DR to landowners may adversely affect both landowners and those who hold DR but own no land. The supply of DR increases, the price may fall, and the elasticity of price with respect to change in supply is critical. At elasticities greater than one, the total value of DR held by landowners will decrease. At any elasticity greater than zero, nonlandowners holding DR will be adversely affected, because the DR price decrease is not offset by issuance of additional DR. Another means of increasing DR supply would be a stock-split—issuing new DR to those holding existing DR. Again, the critical question is that of elasticity of DR price with respect to change in supply. Price may change little if those who receive the additional DR are holding them for speculative purposes. The speculator may have little reason to suddenly begin to sell, DR prices could remain close to previous levels, and DR speculators would enjoy a windfall gain in the value of their holdings. This windfall is a potential, based on the assumption that speculators do not suddenly begin to sell DR and cause a significant drop in DR prices.

Either method of program revision may result in a lower price for DR and lower value of DR holdings for some individuals. If DR are considered property, then a governmental action has decreased the value of individual property, which could be construed as a "taking" under the Fifth Amendment.[8] A similar problem arises if DR are purchased in order to build a high density structure. If the building is later destroyed, are the DR reusable by the owners? What if upzoning has been permitted in the meantime? These complex questions must be considered carefully before any TDR program is initiated.

An Analysis of a TDR Program

There has been much discussion of the theoretical advantages of a TDR program, but

[7] The problem is to provide DR to accommodate continued development demand over time. Initial issuance of enough DR to provide for all future development would greatly oversupply the market initially. Periodic reissuance of DR is usually suggested.

[8] One proposal to avoid this problem is for government to buy all unused DR before any upzoning or reissuance. This could be quite complicated and costly for the public, depending on the degree to which speculation was blocking the needed increase in development density.

to date there has been little effort to explore the impacts of TDR programs in specific applications. Here an analysis is conducted of the types of impacts that might have occurred in conjunction with development around an interstate highway interchange, had a TDR program been in effect. The interchange studied is County Trunk V and I-90 and I-94 in Dane County, Wisconsin (fig. 1).[9] The purpose of the analysis is to examine the implementation process, assess the potential for a smoothly functioning DR market, and examine the compensation issue.

Since it is difficult to predict the market behavior of individuals and DR prices, particularly when market strategy and bargaining power are involved, the analysis is necessarily limited. The analysis takes the form: If restricted landowners were to be fully compensated, what kind of a DR market would be required and what would be the characteristics of such a market? The effect of changes in program implementation on DR distribution and costs is also examined. While this paper summarizes the important empirical results, a more detailed description of the results and research procedures is found in Prenguber.

[9] The interchange area is attractive for a TDR program because the adjacent land has a high, concentrated development demand, because the area is limited in size, and because the interchange has identifiable boundaries and a clear need for land use planning. These characteristics permit detailed analysis of land use change. Wisconsin Department of Transportation (DOT) personnel assisted in identifying a suitable land use plan for the interchange.

Assignment of Development Rights

A hypothetical land use plan was formulated that provided for two development districts (totaling 76.8 acres) and two preservation dis-

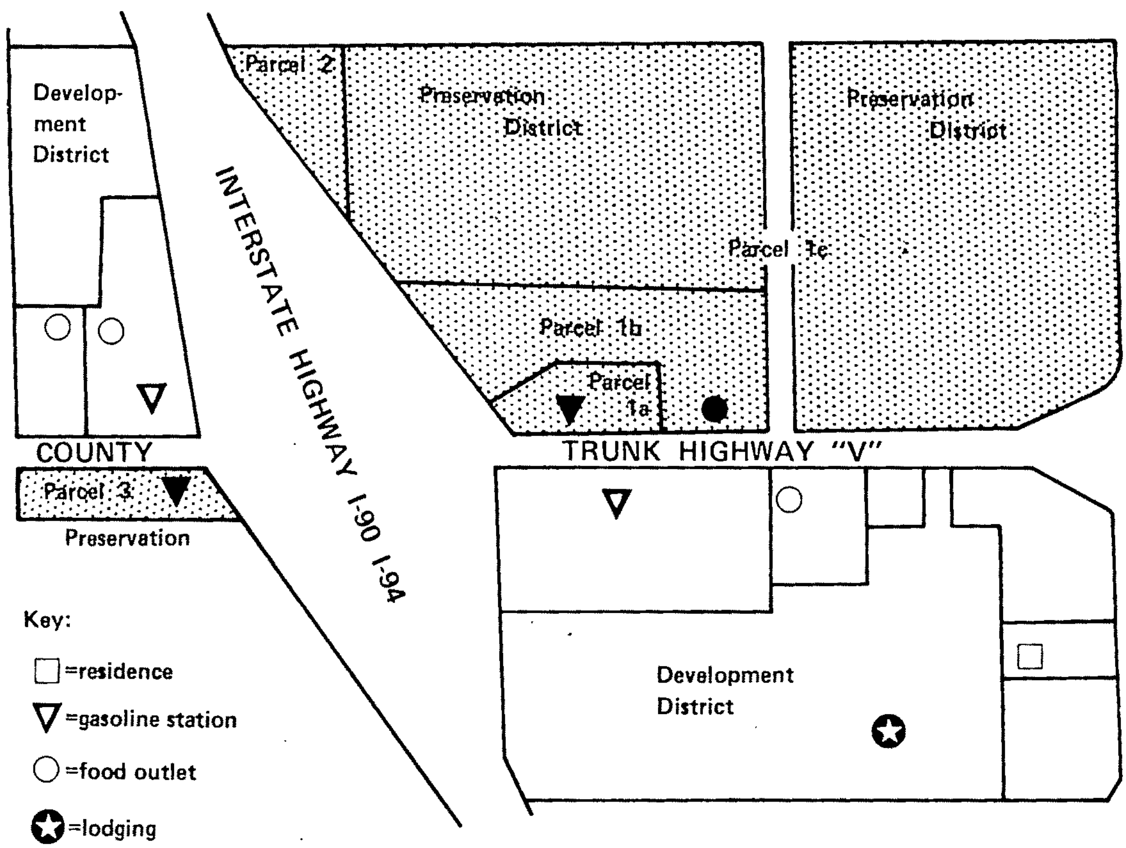

Figure 1. Interstate highway interchange study area. The symbols show where buildings actually stand. The darkened symbols indicate developments that would have been forced to be placed in the development district areas (unshaded) if the TDR program were in effect. Parcel numbers identify the preserved land areas held by the initial recipients of DR. In 1959 at the supposed start of the program, there were three landowners in the preservation districts and three in the development districts. Currently, there are three landowners in the preservation districts and eleven in the development districts.

tricts (totaling 87.3 acres) in the ½-mile square interchange area. Developments which in fact occurred subsequent to highway construction were posited as the planned goal, although the locations of these developments were restricted to the development districts. Each type of development was quantified in arbitrary "development units" (DU). In the initial program, gasoline stations, food outlets, and places of lodging were defined as one DU and residences as 0.5 DU. The total number of developments actually built totaled 9.5 DU. The development district contained 76.8 acres, an average of 8 development district acres per development unit. A TDR program would require downzoning, i.e., require more than the average number of development district acres for each DU. So, instead of requiring 8 acres per DU, 16 acres was the arbitrary density requirement set, but 1 DR could substitute for 1 acre in meeting the density requirement. In order to build 1 DU (e.g., one restaurant or two houses), a developer was required to possess a combination of development district acres plus DR totaling 16, the level of downzoning. DR were distributed to preservation district landowners in proportion to the assessed value of the land in 1959 before highway construction (table 1).[10] The total number of DR distributed was based on the number of DR needed to construct all existing developments at the new higher density levels in the development zone. This process of DU definition and downzoning automatically guaranteed that DR supply would equal DR demand. The balancing of supply and demand was possible only because in the *ex post* analysis, the number of developments was known.

Full Compensation

Since it is not possible to estimate DR prices under bargaining strategies, the question was asked: What price per DR would have to be paid to fully compensate each preservation district landowner? Full compensation is defined as actual value when sold for development minus the agricultural value. The date of sale and price of each land parcel in the preservation districts was known, so agricultural values were subtracted from the development sale price to calculate full-compensation DR values (table 1).[11]

If DR holders knew the value of their DR and did not sell until that price was offered, the wide difference in DR prices shown in table 1 could be expected. Present value or consumer price index adjustments bring the different values to a single point in time without altering the finding that DR prices greatly diverge. If full compensation or some percentage of full compensation were to be achieved by a TDR program, then DR prices would have had to fluctuate widely in this situation. Full compensation implies price instability. Alternatively, a relatively stable DR price per owner would have meant that some owners would have received much more than full compensation and others much less.[12]

[10] DR may also be distributed according to percentage of acreage held. By this method the distribution to the owners was 63.38, 3.91, and 8.70 DR, respectively. While this basis is criticized as not accounting for differences in development potential, in this study both DR distribution methods are very similar (Chavooshian).

[11] Agricultural land value was determined by using Wisconsin DOT condemnation values as a starting (1959) land value and then applying annual appreciation rates. The resulting land values were substantiated by township landowners.

[12] The effect of DR allocation on full compensation DR prices

Table 1. Distribution of Development Rights and Value Required for Full Compensation

Parcel[a]	Acres	1959 Assessed Value of Parcel	Percentage of Total Assessed Value	Distribution of DR	Year of Actual Sale	Value of DR Required for Full Compensation	Present Value of DR (1959) at 8%	Value of DR (1957–59 dollars)
1a	3.1	$ 202	4.16	3.16	1964	$3,319	$2,259	$3,070
1b	9.1	592	12.15	9.23	1964	3,319[b]	2,259[b]	3,070[b]
1c	60.6	3,247	66.63	50.64	1973	804	274	519
2	4.5	293	6.01	4.57	1974	134	42	81
3	10.0	540	11.08	8.42	1964	1,012	689	936

[a] Parcels are those referred to in figure 1. All numbers in the table refer to the entire parcel.
[b] This parcel was sold twice during the study period (1964 and 1971), but the full-compensation DR value is based on the first sale only because it is the compensation to the initial, restricted landowner that is of most interest and because the first purchaser was in fact a development-oriented company. If the average of both sales is the attributed DR value, then the last three columns would read $3,014, $1,197, and $2,138, respectively.

Initial Cost Burdens of TDR

The incidence of the initial burden of DR purchase costs can be approximated for the interchange.[13] It was not known from which hypothetical DR holder a development owner would purchase the necessary DR. Thus, since DR prices varied considerably, it was not possible to assign a specific DR cost to each development. Thus, the weighted average value of a DR was used to estimate the initial costs of the TDR program.[14] Obviously, this is only a crude measure of the initial cost burden of TDR.

The calculation of the average DR value and the specification of additional DR or acreage required for each development provides the information to estimate the initial cost burdens as shown in table 2. There will be some initial cost burden for each development, assuming that the price of development district land is not depressed to exactly offset DR costs. This example assumes that development district land prices are not depressed by DR requirements.

From table 2, it is clear that a TDR program is likely to have differential impacts on various types of development—not all developments will be affected equally. For example, in this analysis, the additional cost varies between gasoline stations and food outlets, and there is even some variation in DR cost within a single category such as gasoline stations. The sensitivity of the incidence of TDR initial costs to DU definition can be analyzed by estimating costs under a different DU ratio. The initial cost burdens can change substantially with what appear to be minor changes in the administrative definition of a "development unit" (table 2). The apparent sensitivity of TDR cost burdens to initial administrative decisions should make any decision maker quite cautious in program initiation. In addition, the sensitivity of initial costs to the DU definition may indicate that these highly technical decisions might properly be made by an elected decision-making body rather than a group of planners. Yet the ability of a body (such as a county board) to deal with such complexities without strong professional guidance must be seriously questioned.

Timing of DR Purchase and Sale

TDR programs could exacerbate timing problems in the land development process if re-

can be seen in this analysis. The highest and best use for the 1959 property assessment was agricultural. Immediately after the Interstate route was fixed, the highest value was in development use, but land assessments remained at a uniform farm-value level. Allocation of DR did not incorporate locational values that arose because of highway construction (this may not be appropriate in any case in a TDR program). If DR allocation were based on post-highway land assessments that reflected post-highway development values, full compensation DR prices may not have diverged so widely.

[13] Only initial cost burdens at the full compensation level can be estimated. The degree of cost shifting from the development owner to the final consumer or to land sellers in the development district cannot be estimated.

[14] Average DR value was calculated by weighting the full-compensation DR value in each parcel by the percentage of total DR contained (table 1).

Table 2. Initial Development Right Cost Burden of TDR Program and Effect of Changed DU Definition on Initial Cost Burden

		Initial Program[a]			Program 2[a]			
Type of Development	Acres Held	Additional DR Needed[b]	Average DR Price	Additional DR Cost	Additional DR Needed	Average DR Price	Additional DR Cost	Change from Initial Program
Gas-Service	8.6	7.4	× $1,197 =	$ 8,858	13.0	× $1,197 =	$15,561	+$6,703
	6.84	9.16	=	10,965	14.76	=	17,668	+ 6,703
	3.1	12.9	=	15,441	18.5	=	22,145	+ 6,704
	2.1	13.9	=	16,638	19.5	=	23,342	+ 6,704
Food outlet	1.8	14.2	=	16,997	9.0	=	10,773	− 6,224
	1.1	14.9	=	17,835	9.7	=	11,611	− 6,224
	0.55	15.45	=	18,494	10.25	=	12,269	− 6,225
	9.1	6.9	=	8,259	1.7	=	2,035	− 6,224
Lodging	19.7	0	=	0	1.9	=	2,274	+ 2,274
Residence	1.5	4.5	=	5,387	1.2	=	1,436	− 3,951

[a] The initial program definition of development unit was: each gas station, food outlet, and motel = 1 DU; residence = ½ DU. Program 2 refers to the same TDR program, except that the DU definition is changed so that one food outlet is still equal to one DU, but each gasoline station and the lodging are defined as two DU and a residence is measured as one-fourth of a DU.

[b] To give uniform treatment for each development activity, the additional downzone density requirement was assumed to have been fully met by DR purchases and not by additional land purchases in the development district.

quirements for DR purchase do not coincide with the willingness of DR holders to sell their rights. Some indication of the potential timing problems can be deduced from the construction history around the interchange. From this history, the DR requirements for the actual developments would have been 46 DR from 1962 to 1966 and 30 DR from 1970 to 1971. The timing of DR holders' willingness to sell requires further assumptions. One assumption might be that DR owners would have tried to sell DR at the same time they actually sold their land. This assumption is reasonable if preservation district landowners actually sold land when they were in need of liquidity for purposes such as retirement. Under TDR, they could no longer sell land for development but could sell DR instead. Under this assumption, DR owners would have wished to sell only 19 DR from 1962 to 1966 and only 8 DR from 1970 to 1971. (The remainder would have been sold from 1972 to 1974.) Thus, in order for the timing of development in the TDR program to follow the historic pattern, many of the DR would have to be exchanged at an earlier period.

However, under alternative assumptions about DR holders' willingness to sell, the timing problems are not so great. It may be hypothesized that preservation district landowners sold land whenever they received a sufficiently attractive offer. If they behave similarly with DR, then a sufficiently high DR price would bring forth the necessary DR supply. Since sale of DR allows the landowner the continued use of the land, the only reason for withholding DR would be in anticipation of increased DR prices or as a bargaining strategy. Also, since DR are perfect substitutes, the DR market may be more like a perfectly competitive market than that for land. Under these conditions, timing may not be a significant problem in the DR market although timing problems could arise due to bargaining strategies or concentration of DR in the hands of a few landowners.

Conclusion

This paper summarizes the issues involved in establishing and administering a TDR program and empirically analyzes the issues of assignment of rights and DU definition, compensation, initial cost burdens, and timing.

Administrative decisions are critical in determining the impact of TDR programs. The analysis revealed that assigning DR according to assessed value may bias DR distribution if assessments do not reflect development value or are otherwise inaccurate. The definition of the "development unit" is also critical. The number of DR which must be purchased for various types of developments will influence the initial cost incidence of the TDR program. The analysis illustrated the shifts in the initial cost burden with changes in the definition of development unit. These decisions on DR assignment and requirements are administrative or political and can greatly affect the impact of the TDR program.

The analysis also suggested that full compensation to restricted landowners would have required widely fluctuating DR prices. Alternatively, stable DR prices would have meant that some owners would receive much more than full compensation and others less.

The initial costs in the highway interchange program varied greatly among different types of development, and there was also variation within a single development category. The final costs may be shared by development and preservation district landowners, developers, purchasers of the development product such as homeowners, or final consumers of products sold at developments such as food outlets.

Finally, the timing of DR requirements may not coincide with DR holders' willingness to sell. Timing problems cannot easily be predicted in advance, but it is quite possible that, even with no timing problems, the DR market will not function as a perfectly competitive market. The necessity of relatively small preservation districts means few DR owners and likely few developers so that bargaining strategies become quite important. The DR market may be characterized by a high degree of speculation, since opportunities abound for wealthy investors to buy DR from low income or illiquid owners with assurance from the planning agency that there will be strong DR demand in the future.

In conclusion, the concept of TDR is promising in that it attacks the windfall-wipeout dilemma that has been the major cause of ineffective zoning controls. However, this paper has identified practical and theoretical difficulties which a TDR program must overcome in order to be a useful tool for land use control. The critical need in TDR research is to apply the concept to real world situations and to study the problems which appear as a well-

developed theoretical concept is applied to the complex realities of the development process. This paper has taken one step in that direction and has identified many potential problems of a highway interchange TDR program. Additional research is needed to simulate TDR programs in other environments. Economists should concentrate future research on the empirical analysis of simulated TDR programs to more clearly identify the problems of TDR, devise solutions, and be better able to advise policy makers on the requirements and impacts of a successful TDR program.

Although this paper has emphasized many problems of the TDR concept, there are several limitations which should be emphasized. First, a detailed examination of any existing land use control program such as shore land zoning would reveal many problems and serious program defects. TDR should not be abandoned simply because there happen to be theoretical and practical difficulties. Second, TDR is a new idea in land use control and as such is not well defined. Research similar to this paper, if conducted in 1920 on the practicality and potential of rural zoning, would have revealed numerous problems and pitfalls. Yet the concept clearly had great merit, as does the yet untested concept of TDR. The need is for more empirical research and experimentation to define and overcome the potential problems of the very promising concept of transfer of development rights. It would be tragic if actual TDR programs were initiated without sufficient preliminary analysis to ensure program success.

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Problems and Solutions in Estimating the Demand for and Value of Rural Outdoor Recreation

Russell L. Gum and William E. Martin

An improved methodology for estimating demand functions for outdoor recreation and evaluating the outdoor recreation resource by use classification is presented. The illustrative framework is a large-scale empirical study of all outdoor recreation activities in all areas of Arizona. The use of the improved procedures produces estimates of resource values which are much larger than in most previous studies and which are about the size of estimates of gross variable expenditures. It is argued that the time has come to relax the search for improved estimating methodology and concentrate on interpretation of the estimates in studies of resource allocations.

Key words: outdoor recreation, demand, value, resource allocation.

The generally accepted Clawson-Hotelling procedure for estimating the demand for and value of a recreation resource involves the two-step process of first estimating statistical demand functions for the total outdoor recreation experience and then deriving the implied demand for and value of the resource itself (Clawson; Clawson and Knetsch; Hotelling). The purpose of this paper is to describe a large-scale empirical study of outdoor recreation in Arizona and improve upon various aspects of recent work utilizing the general Clawson-Hotelling approach by using individual observations for estimating demand relationships, by including the influences of substitute recreation activities, by allowing for individual tastes and preferences for outdoor recreation, and by developing resource values based upon estimated individual demand relationships.

Emphasis is on the methodology but illustrative and summary results are presented. Of special importance is the fact that estimates of resource value are as large as estimates of value obtained by the gross expenditures method—a conceptually indefensible method popular with resource administrators because of its simplicity and large estimated values. Complete empirical results are reported in Gum et al. and in Martin, Gum, and Smith.

The procedure used in this study can be easily adapted to other areas. It is an efficient and reasonably accurate procedure for estimating demand and value. Since the procedure should be acceptable to resource administrators, conclusions suggest that the most fruitful area for additional conceptual analysis is in the interpretation of estimates of value developed for nonpriced goods rather than in additional estimation procedures.

Background

Brown and Nawas (1972, 1973) have improved the estimation of outdoor recreation demand functions by using observations on individual recreators rather than the traditional approach of averaging individual observations within distance zones as with the original Clawson-Hotelling approach. They showed that with the efficient use of individual observations, distance traveled (a surrogate variable for travel time) could be included in the statistical demand equation without introducing problems of multicollinearity with variable costs per trip. The result was an improvement in the specification of the demand model. It reduced the specification bias of the estimated

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coefficients for the important "variable cost" variable and resulted in a larger estimate of value for the recreation resource—no matter which resource value estimate (nondiscriminating monopolist value or consumer surplus value) was computed.

In the same papers they commented that while they had reduced the strong negative bias resulting from the complicating factors of travel time and heterogeneity of participants among the various distance zones, substitute attractions were not treated specifically. While the existence of substitute goods would shift a demand curve to the left, a positive change in the price of substitute goods would shift the curve to the right. Thus, because the prices of substitute attractions were neglected, a negative bias remained in their estimates, conceptually the best made up until that time, 1972.

This current study of rural outdoor recreation throughout Arizona uses a large number of individual observations and includes the mileage variable, as did Brown and Nawas's study. By focusing on all types of rural outdoor recreation activities in all regions of the state, rather than simply on a single activity or a single recreation site, it was also possible to include the prices of substitute attractions in the regression equations.

An additional benefit of basing the analysis on data related to all of an individual's outdoor recreation experiences for a year is that data on total days of all outdoor recreation can be utilized as a shifter variable representing tastes and preferences. By including such a variable one does not have to assume constant tastes among consumers of a recreation good, a point discussed by Sinden.

Seckler (1966, 1968), Sinden, and Stovener and Brown (1967, 1968) have discussed the problems of interpretation of aggregate demand curves for outdoor recreation. Their general conclusions are that the aggregation of separate demand curves for different groups of outdoor recreators provides a more accurate estimate of the "true" aggregate demand curve. It is obvious that better estimates of aggregate demand could be developed by increasing the number of separate groups considered or, better yet, by developing individual demand curves and numerically aggregating them. In this study, demand curves were estimated for each individual in the sample, expanded by an appropriate response rate, and numerically aggregated.

The Arizona Study

The Sample

Given the decision to estimate the demand for all types of rural outdoor recreation in all areas of Arizona, the relevant population to sample for basic data became the total population of the state. In order to have adequate observations for each of the fifty-six equations (eight activities in seven regions), relatively large numbers of responses from all areas of trip origin in the state were needed. The population in Arizona is concentrated in two of the fourteen counties. Thus, a random sample of households was selected within each of the fourteen counties. The sampling rate in each county was adjusted to produce approximately 15,000 addresses to which to mail the fourteen-page questionnaire.

The Questionnaire

The recreation researcher has two alternatives available for accumulating primary data, direct interviews or mailed questionnaires. The average cost of a direct interview necessary to obtain the information required for the overall study was estimated at $30 to $40 compared with approximately $3 per returned mail questionnaire. While decreased accuracy of responses was expected from mailed questionnaires, the large number of responses required and the budget limitations necessitated their use.

Response and Response Bias

A total of 2,926 usable responses, 19.9% of the mailing, were obtained from the 14,713 mailed questionnaires. Usable responses comprised about 0.6% of the total number of households in the state. The response rate ranged from 3.8% of total households in a large, sparsely populated county to 0.2% of total households in the most metropolitan county. Since response to the mailing was not 100%, there was the possibility of response bias.

In order to reduce the effects of response bias, the respondents were classified into five categories. The categories were those households who purchased at least one combination hunting-fishing license, those who purchased one or more hunting licenses only, those who purchased one or more fishing licenses only, those who purchased both hunting and fishing

licenses but did not have a combination license, and those who did not purchase any licenses at all. By comparing response data with actual licenses sold and sampling response by county, representation rates were calculated for each of the five categories and fourteen counties—seventy representation rates in all.

The difficulties encountered when one goes to a large mail sample, stratified by counties, are obviously formidable and invite response bias. The authors were tempted to concentrate on a completely random sample of a well-defined population such as hunting license holders participating in a single activity as Brown and Nawas did. However, if one is to improve model specification by considering alternative activities, if a large number of activities and resource regions are to be considered, and if the participation, expenditures, and socioeconomic characteristics of nonhunters and nonfishermen are to be characterized, the large sample, stratified by location, is necessary.

Estimation of Demand for the Recreation Experience

The first step of the analysis is to estimate statistical demand relationships for the recreation experience as a whole. Demand relationships were derived for: (*a*) deer hunting, (*b*) other big game hunting, (*c*) small game hunting, (*d*) waterfowl hunting, (*e*) predator hunting, (*f*) cold water fishing, (*g*) warm water fishing, and (*h*) general rural outdoor recreation for each of the seven Arizona Department of Fish and Game regions in the state where more than twenty-five area-activity observations were obtained.[1] In total, forty-nine demand relationships were estimated.

The basic form of the relationship was

$$(1) \qquad Q_{ijh} = \alpha_{ij} + \sum_{k=1}^{k} \beta_{ijk} X_{ijkh} + e_{ijh},$$

where Q_{ijh} is the number of household trips for activity i to region j by household h, X_{ijkh} is the value for the independent variable k for person h, and e_{ijh} is the error term.

In searching for stable, statistically significant cost coefficients, each demand relationship was estimated with fourteen alternative selections of independent variables as described in table 1.[2] All formulations contained the crucial average variable cost variables (variables 1 and 2), so that under the second stage of the analysis, added costs could be interpreted as an entry fee per auto into the resource region.

Because of the large number of regression equations estimated (686), the results are only briefly summarized in this paper. The number of observations per equation ranged from 25 to 268 for hunting, from 53 to 615 for fishing, and from 210 to 644 for general rural outdoor recreation. As Brown and Nawas (1973) noted, R^2 values were not high. The ranges and means for the equations selected as the "best" for each region and activity are as follows: hunting—twenty-nine equations with R^2's of 0.09 to 0.82, mean = 0.33; fishing—thirteen equations with R^2's of 0.07 to 0.59, mean = 0.32; general rural outdoor recreation—seven equations with R^2's of 0.21 to 0.40, mean = 0.32.[3]

However, the objective was not specifically to obtain high R^2 values but rather to obtain the reliable estimates of the structural parameters, especially those of the cost variable from which the value of the resource itself is derived. For the forty-nine equations selected as "best," forty-two of the coefficients on cost had t-values above 1.7 and thirty-four of the t-values were above 2.0. Twenty-eight of the coefficients on cost squared were above 1.7 and nineteen were above 2.0.

As Brown and Nawas found, when mileage (travel time) is excluded from the equation, the linear cost coefficients are usually more negative than when mileage is included as a

[1] General rural outdoor recreation, all recreational trips for which hunting and fishing was not the main purpose, was treated as a single activity. Included are day picnicking, overnight camping, hiking, swimming, boating, water skiing, snow skiing, and bird watching. Because of the heterogeneous nature of this group of activities, results for this group should be interpreted with caution.

[2] A "stable" coefficient is defined as a coefficient that remains almost constant in alternative formulations of the model. Thus, one could conclude that regardless of the R^2 or the contribution of other variables to the total explanation of variance, the coefficients in question have been estimated as "correctly" as possible with the available data.

[3] Selection of the "best" equation requires both art and science. For each area-activity, selection 14 (cost variables only), selection 13 (cost and distance variables only), and one other selection containing cost, distance, and cost of alternative activities (variable 7) with a "good" combination of t-values, "correct" signs and R^2 were evaluated in the second half of the two-step, Clawson-Hotelling procedure. Where the equation, including variable 7, met all the above criteria and gave reasonable resource values when compared to other similar areas and activities, that equation was chosen as "best." Next in line was selection 13, including the distance variables as well as the cost variables. The last choice was selection 14 including the cost variables only.

Table 1. Variables Included in Each of Fourteen Equations on Each Activity in Each Region

	Selection													
Variables[a]	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dependent variable														
Number of trips for activity *i* to region *j* in 1970	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Independent variables														
1. Average variable cost of trips *ij*	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2. (Variable 1)^2	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3. Average round trip mileage *ij*	x	x	x	x	x	x	x	x	x	x	x	x	x	
4. (Variable 3)^2	x	x	x	x	x	x	x	x	x	x	x	x	x	
5. Total days of outdoor recreation taken in 1970	x	x	x	x	x	x	x		x		x			
6. Total dollars of outdoor recreation variable expense in 1970	x	x	x	x	x	x	x					x		
7. Average variable cost of all other recreation trips taken, excluding trips *ij*	x		x		x	x			x	x				
8. Total recreation days as a proportion of vacation days	x	x	x	x	x			x						
9. Total recreation variable expense as a proportion of income	x		x	x				x						
10. Average variable cost of all other hunting trips	x	x												
11. Average variable cost of all other fishing trips	x	x												
12. Average variable cost of all other general rural outdoor recreation trips	x	x												
13. Age	x													
14. (Age)^2	x													
15. Vacation days	x													
16. (Vacation days)^2	x													
17. Education	x													
18. (Education)^2	x													
19. Income	x													
20. (Income)^2	x													

[a] Data relate either to total household (e.g., cost data) or to head of household (e.g., age).

variable, and the resultant consumer surplus values developed in step two of the analysis will be smaller. In either case, the coefficients on cost may have high t-values. Thus, the Brown and Nawas conclusions are partially confirmed. Estimates of recreational values derived from grouped data will usually underestimate the value of the resource since mileage or travel time cannot be included without problems of multicollinearity. There are exceptions, however, depending on the type of activity and the distances involved. For example, small game is usually hunted relatively close to home. For most Arizona regions for hunting small game, the coefficient on the mileage variable was close to zero with a very small associated t-value.

Variable 5, total days of rural outdoor recreation taken in the year, proved quite important in stabilizing the cost coefficients. The coefficient on total days was consistently positive. For the activities of fishing and general rural outdoor recreation, t-values reached as high as 12. This variable may be viewed as a surrogate for positive tastes and preferences for rural outdoor recreation. Inclusion of this variable again tends to reduce the size of the linear cost coefficients (makes less negative) though not nearly as much as did the inclusion of the mileage variable.

Inclusion of most other variables listed in table 1 did not have consistent results. Inclusion or exclusion did not materially change the size of the estimated coefficients on costs. However, in many cases, the coefficient on variable 7, the average variable cost of all other rural outdoor recreation trips taken, was positive, with t-values ranging from 0.75 to 2.98. In these cases, this equation was chosen as "best" if all other criteria were met (see

note 3), since the inclusion of the prices of substitute activities should lead to better model specification.

Results are summarized in table 2 in the form of price elasticities of demand. The elasticities are computed at the mean variable cost per household trip and mean number of household trips taken in 1970 with zero additional cost. Demand for rather expensive hunting activities such as deer hunting and hunting other big game is quite inelastic and so is demand for fishing in the better fishing regions and the demand for general rural outdoor recreation throughout the state. Demand for hunting predators and waterfowl is much more elastic. These are relatively minor activities in most regions of the state and are participated in only where there is relatively easy access at low cost.

One would expect more inelasticity in regions with a high quality of the relevant resource. In general, this expectation is borne out by the data of table 2. For example, elasticities for deer hunting are quite low in all regions except the rather poor hunting region 5 surrounding the population center of the state at Phoenix. Elasticities for cold water fishing are lowest in regions 1 and 2 which encompass the high mountain areas of the state. Checking against the size of the t-values on the estimated coefficients (Martin, Gum, and Smith, pp. 42–51), one generally would have more confidence in the middle values for elasticities in each column of table 2 than in the extreme values for each column.

Deriving Resource Values

In the second step of the Clawson-Hotelling approach to recreation demand, the aggregate statistical demand curve (which describes the demand for the total recreation experience) is used to estimate a second demand curve which describes demand for the specific resource itself when used for the activity in question. For example, the statistical demand curve for the total experience of hunting deer in region 7 is used to develop a demand curve that describes the alternative quantities of deer hunting trips that would be made to region 7 at alternative additional costs—at alternative entry fee charges, for example. Of course, access to the region for the activity is now free and probably always will be, but we wish to know how much households would pay and participate if a fee were charged. This is the standard Clawson-Hotelling approach (Clawson and Knetsch, pp. 77–85).

It is important to carefully define the relation between the aggregate demand curve for the total recreation experience and the statistical estimate of individual demand curves for the total experience. The aggregate demand is equal to the horizontal summation of the individual demand curves for all possible individual quantity-price relations. Possible is defined to allow only positive prices and quantities. This is not equivalent to a simple expansion of the average individual's demand curve (Nawas, p. 121). In fact, the true aggregate demand curve will always lie to the right of the expanded average curve unless all individuals had exactly the same socioeconomic characteristics (income, tastes, and preferences, etc.). Thus, all studies based on the expansion of average curves have given underestimates of the resource values. Since it is impossible to develop demand relations for every individual using a recreation resource, it is necessary to sample the user population and expand the individual demand curves by the

Table 2. Estimated Price Elasticities of Demand for Recreation Activities

Arizona Dept. of Game & Fish Region[a]	Hunting					Fishing		General Rural Outdoor Recreation
	Deer	Other Big Game	Small Game	Predators	Waterfowl	Cold Water	Warm Water	
1	−0.43	−0.33	−1.06	−0.63	−0.67	−0.40	−0.48	−0.12
2	−0.30	−0.39	−0.52	−0.58	−1.24	−0.38	−0.65	−0.15
3	−0.44	—	−0.74	−1.78	—	−0.41	−0.31	−0.35
4	−0.21	—	−0.68	—	−1.58	—	−0.33	−0.56
5	−0.87	−0.23	−0.54	−1.91	—	−0.74	−0.44	−0.30
6	−0.27	−0.40	−0.36	−0.82	—	−0.59	−0.83	−0.14
7	−0.27	−0.62	−0.52	−1.29	−1.05	−0.97	−0.85	−0.36

Note: Elasticities are computed at the mean variable cost per household trip and mean number of household trips taken in 1970 with zero additional cost.
[a] See Martin, Gum, and Smith (p. 6) for region boundaries.

inverse of the probability of sampling the individual. For the purposes of this study, demand curves were estimated for each household in the sample, expanded by an appropriate response rate and numerically aggregated to provide an estimate of the aggregate demand curve from which resource values are derived.

It is true that the individual demand curves assume that each individual has the same coefficients on the two cost variables, but each curve is individual in that it meets the quantity axis at zero added cost (the individual's actual cost) at the exact quantity observed for that individual.

Thus, in general, an individual household's demand for a specific type of recreation and region can be expressed as Q (trips) $= fn$ (money cost, time cost, socioeconomic variables, tastes, and preferences). By utilizing a statistical estimate of such a function, the estimate of demand for an individual household can be expressed as

$$(2)\quad \hat{Q}_{0h} = a + b_1 \text{ cost}_h + b_2 \text{ cost}_h^2 + \sum_{k=3}^{n} b_k X_{kh},$$

where $\hat{Q}_{0h}$ = estimated household trips taken at zero additional cost for household h, a = the intercept, cost_h = average variable cost per trip for household h, $b_1, \ldots, b_n$ = regression coefficients applicable to the recreation type and region considered, and $X_{3h}, \ldots, X_{nh}$ = all variables other than cost for household h. For an additional cost c the estimate of visits $\hat{Q}_c$ becomes

$$(3)\quad \hat{Q}_{ch} = a + b_1 (\text{cost}_h + c) + b_2 (\text{cost}_h + c)^2 + \sum_{k=3}^{n} b_k X_{kh}.$$

Subtracting equation (3) from equation (2) and rearranging terms,

$$(4)\quad \hat{Q}_{ch} = \hat{Q}_{0h} + b_1(c) + 2b_2 (\text{cost})_h (c) + b_2(c)^2.$$

Thus, the estimate of the demand curve for an individual can be expressed in terms of the number of trips taken at zero added cost ($\hat{Q}_{0h}$), the average variable cost incurred for those trips (cost) and the incremental charges, c, as shown in equation (4).

Applying equation (4), each regional activity was evaluated using the following computerized procedure. (*a*) A new demand curve for each individual household was calculated, using the household's observed number of trips as maximum trips at zero additional cost. The household's decrease in trips was estimated as additional costs increased, until the household's trips became zero or started to increase. (The estimated number of trips could begin increasing in certain cases where the statistical demand curve reached a minimum before touching the cost axis. Since an increase in activity in response to increased cost is not logical, estimated activity was set at zero if the minimum point was reached before estimated activity reached zero.) This procedure utilizes the actual number of trips taken by a household and its actual average variable costs per trip to define the household's individual demand curve. Only the two regression coefficients on cost are utilized—thus, the emphasis on eliminating specification bias in developing the statistical demand equation. All independent variables other than the two cost variables are ignored, since the effects of these shifter variables are included by computing individual demand functions starting with actual trips at zero added cost. (Added cost = 0, 1, 2, 3, . . . , 1,000.) (*b*) Estimates for each individual household were expanded by the relevant response rate and adjusted by the relevant representation rate. (*c*) Expanded and adjusted individual demand curves were aggregated. (*d*) The aggregate number of trips and the associated total revenue were calculated and printed out at each level of added cost. (*e*) The nondiscriminating monopolist value (maximum total revenue), and associated added cost and number of trips were selected by inspection. (*f*) The consumer surplus value was numerically calculated as the cumulative sum of aggregate trips when aggregate trips varied from maximum to zero at intervals of $1 added cost.

An example of the results as developed for each activity for each region is given in table 3. (Added costs are shown at $5 intervals up to $50, and $10 intervals thereafter until revenues fall to zero in this example.) In 1970, an estimated 24,250 household trips were made to region 1 for the purpose of hunting deer. A certain amount of variable expense was associated with these trips, but there was no entry fee to the region. Therefore, added costs were zero. Had there been added costs of $5 per household trip, imposed either as an entry fee or simply occurring for another reason associated with the trip, it is estimated that only 20,176 household trips would have been made. If the added cost was in the form of a fee, $100,880 would have been collected.

If higher levels of added cost had occurred, the number of trips taken would have been less

Table 3. Estimates of Resource Values for Use in Deer Hunting, Arizona Department of Game and Fish Region 1, 1970

Added Cost per Household Trip ($)	Number of Household Trips	Total Revenue ($)
0	24,250	0
5	20,176	100,880
10	17,484	174,845
15	14,722	220,833
20	13,186	263,724
25	12,083	302,095
30	11,089	332,673
35[a]	9,826	343,934[b]
40	8,420	336,800
45	6,357	286,103
50	5,925	296,261
60	4,063	243,812
70	1,466	102,654
74	0	0
Consumer surplus value		739,460

[a] Nondiscriminating monopolist price for the activity in the region.
[b] Nondiscriminating monopolist value for the activity in the region.

and less until, if an added cost of $74 per household trip had occurred, no trips would have been taken. Had the added cost been in the form of an entry fee, total revenues could have been maximized at a price of $35 per trip. While the elasticity reported in table 2 was −0.43 for the average household at zero additional cost, the elasticity of demand for the activity and site itself has risen to 1.0 at the nondiscriminating monopolist price and continues to rise to infinity at a price of $74. Because the demand relationship is curvilinear, rather than simply linear, the consumer surplus value of $739,460 is not merely twice the size of the nondiscriminating monopolist value.

Conclusions

It has been shown that relatively successful demand functions for nonpriced outdoor recreation activities can be developed for a large area and for many activities in a relatively inexpensive manner. Problems of sampling arise but are not insurmountable. Model specification can be enhanced by a large-scale study since alternative activities can be included in the model. By going to the individual observation approach, the problems of multicollinearity between the cost variables and the distance variables are avoided. By aggregating individual demand curves based on each individual's actual quantity of participation and actual variable cost, the different rates of participation induced by people's different tastes and preferences for outdoor recreation are easily introduced into the model, and a better approximation of the true aggregate demand curve is achieved.

What are the implications of these results on the practical application of work in the economics of outdoor recreation? Probably most important is that estimates of resource values derived using these procedures are as large as the values derived by the old gross expenditure method of evaluating recreation activity which has been favored by practical resource administrators.

One reason that the gross expenditure method has been popular is that "such estimates are likely to yield large figures, which give the impression of a large and profitable tourist-recreation business. Indeed, this is often one of their chief purposes" (Clawson and Knetsch, p. 224). Past studies of recreation demand, using the traditional Clawson-Hotelling approach with the data averaged within distance zones, have consistently given nondiscriminating monopolist and even consumer surplus values that were smaller than the gross expenditure estimates.

The comparisons of resource values with gross variable expenditures for Arizona are shown in table 4. Activities are aggregated over all regions. The nondiscriminating monopolist values are larger in total than variable expenditures, tend to be about as large or larger for the more important activities involving considerable travel and other expense, and are significantly smaller only for the activities of waterfowl and predator hunting. Consumer surplus exceeds gross expenditures for all activities except waterfowl and predator hunting. For these two activities the values are of similar magnitudes.

When the estimates of total dollars are converted to dollars per trip, the difference between the nondiscriminating monopolist price per household trip and variable expense per household trip becomes even more striking. Average consumer surplus values per household trip are of the same general magnitude as nondiscriminating monopolist prices.

The relative sizes of the value versus gross expenditure estimates are not mere coincidence. Because of the inclusion of average

Table 4. Nondiscriminating Monopolist and Consumer Surplus Values Compared to Actual Variable Expenditures

Activity	Variable Expenditures	Nondiscriminating Monopolist Value	Consumer Surplus Value	Average Variable Expenditures per Household Trip[a]	Nondiscriminating Monopolist Price per Household Trip[b]	Average Consumer Surplus Value per Household Trip[a]	Estimated Household Trips, 1970	Projected Trips at Nondiscriminating Monopolist Price
All hunting	$14,404,064	$13,885,814	$34,480,415	—	—	—	—	—
Deer	4,512,211	3,717,064	11,246,250	$21.20	$60.00	$52.85	212,812	61,948
Other big game	2,650,100	2,034,966	6,100,267	24.94	40.00	57.43	106,220	50,872
Small game	5,355,458	7,752,495	15,651,167	8.18	35.00	23.89	655,009	221,479
Waterfowl	620,608	127,412	580,882	10.55	20.00	9.87	58,840	6,369
Predator	1,265,687	253,877	901,749	8.97	5.00	6.39	141,058	50,773
All fishing	$23,422,915	$30,057,922	$64,374,326	—	—	—	—	—
Cold water	14,065,759	11,225,685	30,244,477	23.31	40.00	50.13	603,343	280,639
Warm water	9,357,156	18,832,237	34,129,849	12.59	60.00	45.92	743,269	247,203
General rural outdoor recreation	$36,966,767	$47,639,237	$144,381,917	15.50	60.00	66.54	2,384,833	793,984
Grand total (all activities)	$74,793,746	$91,582,973	$243,236,558	—	—	—	—	—

Note: Activities are aggregated over regions. Estimates are those of and for Arizona residents only. Expenditures, values, and trips of and for nonresidents are not included.
[a] Based on estimated number of household trips, 1970.
[b] Based on estimated number of household trips that would occur at the nondiscriminating monopolist price.

cost in the demand relations derived to show reaction to additional costs, equation (4), there is a relationship between expenditures and values. The specific relationship is not a simple one and depends both on the coefficients estimated for the demand function and upon the distribution of average expenditures within a sample of recreators. Even though there is a relationship between the methods, one method of estimation has an acceptable conceptual base and the other does not. However, the comparisons do show that as the newer methods are adopted, the recreation demand approach may compete successfully on the basis of public relations as well as on its conceptual base.

Given that decisions about alternative uses of natural resources are being made every day, that one of these alternative uses is the nonpriced good of outdoor recreation, that reasonable estimates of the demand for and value of outdoor recreation can be made on a rather large-scale basis, and that resource administrators should find these estimates acceptable, a very practical conceptual problem remains. Exactly how may the prices and values derived for this nonpriced good be compared to the prices and values estimated for market-priced uses of the natural resource base such as use for timber, grazing, and water runoff? The authors have made tentative applied efforts at such comparisons in Martin, Gum, and Smith (pp. 31–36), but much conceptual challenge remains.

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School Consolidation in Sparsely Populated Rural Areas: A Separable Programming Approach

David W. Holland and John L. Baritelle

The purpose of this study was to investigate the relationship between internal schooling economies and transportation costs with regard to consolidation of rural schools. The consolidation question was conceptualized as a programming problem where the objective was to simultaneously minimize the sum of schooling and transportation costs. Both linear and separable programming models were used. Model solutions indicated that some consolidation of schools in the study area would minimize costs but total cost savings were relatively small.

Key words: internal schooling economies, transportation costs, school consolidation, linear programming, separable programming, cost minimization.

The advisability of rural school consolidation turns on many different issues. Parents of students voice concern about loss of local control, long bus rides, and fewer real opportunities for extracurricular activities. Public officials and their advisors often seem to concentrate on what are viewed as the economics of the question. Since schooling is apparently a process that is characterized by internal economies of size, major cost savings should be obtainable through consolidation of rural schools which are too small.[1]

What is often missing in policy deliberations is explicit recognition of the cost of transporting students. If large increases in transportation costs are associated with consolidation, then recommendations based mainly upon presumed savings from size economies are likely to be wrong. The principal purpose of the study reported in this paper was to examine the trade-off between schooling costs and transportation costs as optimum school size and location are affected. The secondary purpose was to examine the usefulness of separable programming as an analytical tool in examining the issue of school consolidation.

Previous studies have tended to concentrate upon either the transportation or schooling economies aspects of the consolidation question. Schruben and Nelson were concerned with bus routes and used the lockset method to develop lower cost bus routes for school districts in Kansas (1972a, 1972b).[2] Ricker and Tyner estimated enrollment-expenditure relationships for Florida schools and used linear programming to determine how counties should be consolidated in order to minimize total "in-school" costs. Transportation and capital costs were specifically excluded.

White and Tweeten addressed both transportation and size economies aspects of the consolidation question. By surveying school children in Oklahoma, information on the relationship between family background, schooling factors, and academic achievement was obtained. Production functions identifying the relationship between schooling inputs and schooling output were estimated. These production functions provided the basis for construction of education cost curves, showing

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[1] Although most economic studies have revealed a decline in spending per student as a function of enrollment, the findings remain somewhat clouded by the difficulty of correctly accounting for quality of education (see, for example, Osburn, Cohn, and Ricker and Tyner).

[2] The lockset method selects improved routes but does not select the optimum route in a mathematically rigorous sense. It would therefore be incorrect to refer to routes selected by this method at least cost.

how costs of providing a given level of education varied with school size. The curves were long-run in nature and were exclusive of transportation. Transportation costs were separately calculated as a function of hypothetical levels of student density. Transportation costs and education costs were vertically summed to obtain the long-run average total cost curve. The minimum point on the curve identified optimal school size. Separate curves were constructed for different student densities.

In the White and Tweeten study, the hypothetical district was assumed to have a square road grid system and students were assumed to be dispersed evenly throughout the district. Only the possibility of one central school was considered. These assumptions place undue limitations on the analysis. Typically, road grid systems are not square and students are not evenly dispersed. Further, many schools will often be in operation and many possible combinations of school consolidation must be considered in larger counties.

To account for these complexities, a separable programming model was developed for a study county in eastern Washington state. That combination of school size and location which minimized the sum of schooling and transportation costs was calculated. Both short-run and long-run solutions were obtained. Although model coefficients were derived from Washington data, the general issue and analytical method are believed to be of wide interest and application.

The Economic Model

The basic model used to determine optimum school size and geographic area served by each school has been used in many studies of interregional competition (see Kloth and Blakley, for example) and may be defined as follows:

$$(1)\quad \min \quad TC = \sum_{j=1}^{n}\sum_{i=1}^{m} T_{ij}X_{ij} + \sum_{j=1}^{n} f(X_j),$$

$$(2)\quad \text{subject to} \sum_{j=1}^{n} X_{ij} = S_i \; (i = 1, \ldots, m,)$$

$$(3)\quad \sum_{i=1}^{m} X_{ij} = X_j \; (j = 1, \ldots, n,)$$

and

$$(4)\quad X_{ij} \text{ and } X_j \geq 0,$$

where TC = total transportation and schooling cost, T_{ij} = transportation cost per student from area i to school j, $f(X_j)$ = nonlinear function expressing total cost of educating X_j students in school j, X_{ij} = number of students transported from area i to school j, S_i = number of students residing in each area i, X_j = number of students at each school j, $\sum_{j=1}^{n}\sum_{i=1}^{m} T_{ij}X_{ij}$ = total transportation cost for students from areas i to schools j, and $\sum_{j=1}^{n} f(X_j)$ = total schooling cost of schools j.

Students from m different areas were visualized as being able to attend each of n possible schools. The desired solution was to find the least-cost pattern of transporting and educating students while meeting constraints on student location and schooling capacity. Schooling size economies in equation (1) are effective through $f(X_j)$ which is representative of the nonlinear schooling cost curve. The functional $f(X_j)$ is used to approximate the cost curve as a series of piecewise linear segments. A more complete description of the segmenting procedure and separable programming may be found in the IBM Users' Manual.

The strength of the programming approach is that it specifies optimum school size, area served, and the magnitude of cost savings. A disadvantage of the approach is its lack of ability to adequately consider potential economies from more efficient routing. Also, the technique is not well suited to considering a large number of potential school locations. For each potential location, the problem matrix expands by the total number of student areas. Unless care is taken, apparently simple problems can become very large matrices. The model is dependent upon detailed student location data and requires accurately specified schooling functions. To the degree that these factors are weak, so is the programming approach.

Administrators were viewed as facing three distinct planning horizons: very short run, short run, and long run. In the very short run, only the district boundary was subject to variation. Boundaries could be modified to minimize transportation costs subject to the restriction that school enrollment not be changed. Linear programming was used to minimize transportation costs subject to existing student location and school enrollment.

The short run was assumed to be characterized by possible variation in all factors except plant size. Teachers could be hired or fired, equipment purchased, or new support personnel employed, subject to the constraint of the existing physical plant. The short-run solution utilized separable programming to minimize transportation and schooling costs subject to the constraint of existing building capacity.

In the long run, all factors, including plant size, were assumed variable. Optimal school size and transportation pattern were selected with all factors, including building size, variable. Solutions were also obtained, under long-run assumptions, for alternative projections of student numbers and fuel costs. A summary of model attributes under the various alternatives is provided in table 1.

The Study Area and Data Collection

Lincoln County, an area near Washington State University, was chosen for purposes of convenience and economy. The county measures 43 by 53 miles and has nine school districts serving all of Lincoln County, as well as some students living in four adjacent counties. The population density of the county is relatively low at 4.08 individuals per square mile. The towns are of similar size, ranging in population from 405 to 1,370. Each of the eight incorporated towns in the county has both an elementary and a secondary school. Edwall, an unincorporated community, has only an elementary school. County and existing school district boundaries are depicted in figure 1.

The major data collection task was to determine the location of all elementary and secondary students within each district. This information was gathered during interviews with either district superintendents, their transportation supervisors, or individual school bus drivers. These respondents were asked to identify current bus routes on a county map and to locate each student pickup point.

Estimates of current enrollment, capacity enrollment, and projected future enrollment were also obtained by interviewing district superintendents. Enrollment capacities were defined in terms of existing physical plants. Estimates represented an average classroom size of twenty to twenty-five students. Every school except Reardan was found to have considerable excess capacity (table 2).

To aid in data processing, student location data were grouped into township boundaries. The total student population in each of these units was treated as if it were located at a central collection point roughly reflecting the population distribution for that township. The "most likely traveled" distance from each township to each school was then calculated.

Table 1. Model Attributes

Model Number	Student Numbers at Each School Fixed	Students Constrained to Present School	School Plant Size Fixed	School Boundaries Fixed	Capital Costs Included in School Cost Function	Student Numbers Projected to 1984	Fuel Costs Increased 200%
Very short run							
Model 1	yes	yes	yes	yes	no	no	no
Model 2	yes	no	yes	no	no	no	no
Short run							
Model 3	no	no	yes	no	no	no	no
Model 4	no	no	yes	no	no	yes	no
Model 5	no	no	yes	no	no	yes	yes
Long run							
Model 6	yes	yes	yes	yes	yes	no	no
Model 7	no	no	no	no	yes	no	no
Model 8	no	no	no	no	yes	yes	yes

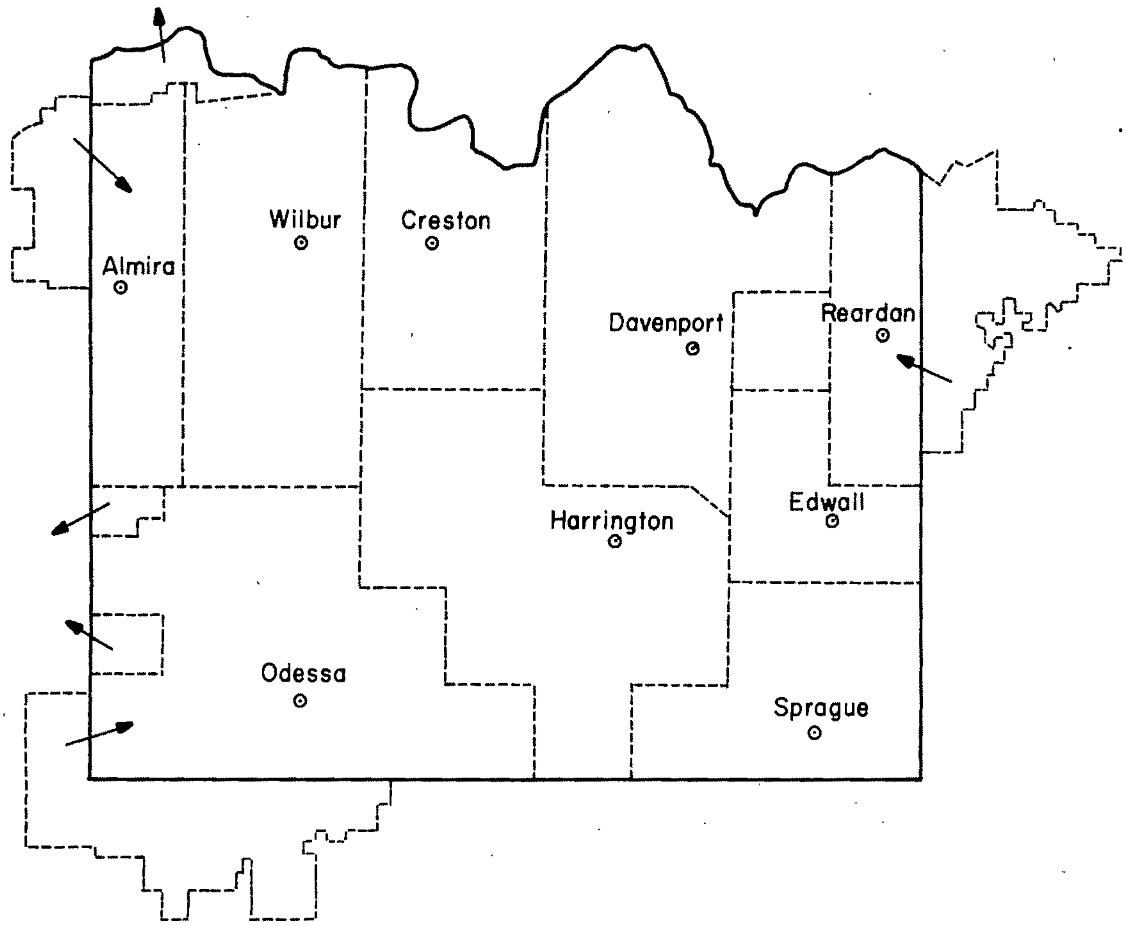

Figure 1. School district boundaries, Lincoln County

Transportation and Schooling Cost Estimates

School bus operating costs (including depreciation) were obtained from transportation budgets for the respective school districts from the Office of the Superintendent of Public Instruction (Washington 1973a, 1973b).

Table 2. Lincoln County Schools' Student Enrollment and Capacity, 1973–74

Schools	Enrollment	Capacity Enrollment
Almira	162	320
Creston	140	240
Davenport	443	645
Edwall	77	90
Harrington	104	150
Odessa	392	500
Reardan	457	475
Sprague	139	367
Wilbur	210	500

Since cost per mile was relatively uniform across districts, the mean value for Lincoln County was estimated to be \$.41 per mile for all districts and was employed as the transportation cost in the programming model. It was implicitly assumed that transportation cost per unit of distance was not sensitive to school size or location.[3]

Schooling cost curves were developed under the assumption that schooling quality was the same in all sampled schools.[4] The

[3] This eliminates consideration of potential transportation cost savings arising from consolidation of maintenance, purchasing, and insurance associated with the transportation operation. Also neglected are potential savings from more efficiently designed school bus routes.

[4] It is recognized that detection of economies of size in schooling requires that education quality be held constant. Lincoln County was a very favorable study area in this respect. All communities in the county were relatively homogeneous, and the educational programs of the respective schools were similar. Vocational education does not receive strong attention. No significant difference was thought to characterize family background factors which affect schooling. Although the Lincoln County school system does not uniformly administer standardized achievement tests,

schools in the study area have retired nearly all bonded indebtedness and for all practical purposes face only negligible fixed costs for buildings and equipment. To represent the short run for these schools, cost per pupil reflects operating cost only.[5] An envelope of low points was obtained from the cost data for the nine schools.[6] This curve was treated as representative of the cost of efficiently operating existing schools at current and up to capacity enrollment.[7] Such a curve would embody certain size economies and was viewed as somewhat similar in concept to a long-run average cost curve less construction costs.

The criterion used to fit the curve was to minimize the difference between observed cost and predicted cost for each school, subject to predicted values being equal to or less than observed values.[8] The curve was estimated as quadratic and is depicted in figure 2.[9]

The long-run curve was developed assuming all factors variable.[10] Estimates of the long-run curve were based on current expenditures plus a prorated estimate of building costs. Construction cost information was obtained from White's study and adjusted for inflation.[11]

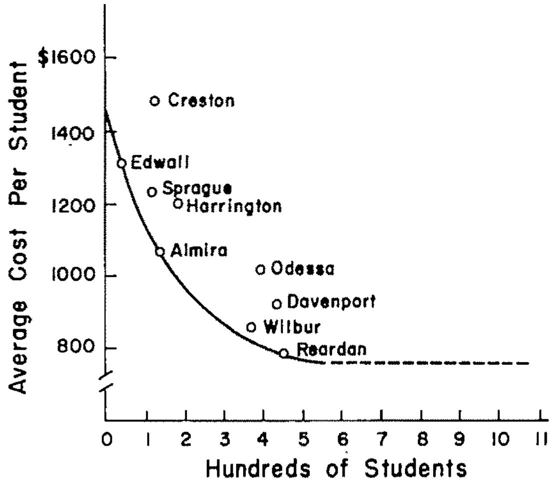

Figure 2. Quasi long-run average cost curve less construction costs for public schooling in Lincoln County. $C = 1422.68 - 2.5576S + 0.002478S^2$, where C = average cost per student, 1972–73 school year, and S = number of students.

Findings: Very Short Run

The findings of the very short-run analysis are summarized in table 3. Findings under model 1 represent current practice and provide a standard of comparison for model 2. Model 2 was identical to model 1 except that students were not constrained to specified schools; however, school size was constrained to existing enrollment levels. Average cost per student per school was taken as a point estimate from the curve depicted in figure 2. Minimization of costs in model 2 was therefore equivalent to minimizing transportation costs, and it was in this manner that optimum school district boundaries in the very short run were defined.[12]

The reduction in transportation cost under model 2 was small, only $2,724 out of a transportation budget of $346,276 for model 1. In

the superintendents felt that there would not be significant differences in achievement test scores by school.

[5] Data were obtained from school district annual financial reports. The reflected school functions include administrative and teaching salaries, supplies, maintenance, plant operating expenses, and some auxiliary services. Transportation costs were excluded.

[6] Edwall was included even though it was an elementary school because it afforded the only observation available on schools with very small enrollment.

[7] The estimated curve provides a somewhat biased estimate of cost savings associated with enrollment expansion in the short run, that is, individual schools would probably not be able to expand along the derived curve but rather along curves exhibiting somewhat less downward slope.

[8] The programming format may be summarized as follows:

$$\min \sum_{j}^{n} (C_j - \hat{C}_j),$$

subject to $\beta_0 - \beta_1 X_j + \beta_2 X_j^2 < C_j\, j = 1, \ldots, n$, and $\beta_0, \beta_1, \beta_2 > 0$, where C_j = average total cost per student of the jth school, $\hat{C}_j$ = predicted average total cost per student of the jth school, and X_j = the number of students in the jth school expressed in hundreds. An envelope curve was preferred to a regression curve because of the difficulty of interpreting observations below the latter. Furthermore, the least-squares criterion tends to accentuate extreme observations which the programming approach does not (Aigner and Chu, Timmer).

[9] Two alternatives were examined with regard to the behavior of the curve beyond the range of the data. One alternative assumed that all significant economies were reached by the size of the largest observed school and that the curve was flat thereafter. The second choice assumed that the curve continued to decline beyond the range of the data but at a slower rate than characterized by the decline in the first part of the curve. Considerable testing indicated no difference in the geographic allocation of schools and students. For this reason, results for only the first alternative are discussed in this paper.

[10] Perhaps the most realistic approach would be to visualize the district as facing a discontinuous quasi long-run curve. Such a curve would correspond to the operating cost curve up to plant capacity but would indicate increased cost for new buildings and equipment for any further increase in student numbers.

[11] A single cost function was developed for a representative school district assuming that two buildings, each serving an equal number of elementary and secondary students, would be constructed. The buildings were assumed to lose 80% of their value over a period of fifty years.

[12] Time constraints with regard to length of bus ride were not included in the models, because after several runs it became clear that boundary changes requiring large increases in time and distance were not coming into the final solutions.

Table 3. Minimum Transportation Cost in the Very Short Run: Schools Constrained to Present Enrollment

	Model 1			Model 2		
Schools	Student Numbers	Cost of Transportation	Schooling Cost	Student Numbers	Cost of Transportation	Schooling Cost
Almira	162	$ 22,589	$ 170,559	162	$ 21,847	$ 170,559
Creston	164	17,979	172,217	164	18,350	172,217
Davenport	457	44,327	354,496	457	43,275	354,496
Edwall	76	12,068	93,192	76	12,068	93,192
Harrington	187	23,796	191,281	187	22,031	191,281
Odessa	397	58,079	316,800	397	58,079	316,800
Reardan	453	104,343	351,966	453	105,271	351,966
Sprague	144	13,801	155,640	144	13,801	155,640
Wilbur	402	49,294	319,713	402	48,830	319,713
Subtotals	2,442	$346,276	$2,125,865	2,442	$343,552	$2,125,865
Total costs		$2,472,140			$2,469,417	

other words, very little saving in transportation cost was available, given existing school enrollment and location. District boundaries under model 2 were only slightly changed from existing boundaries.

Findings: Short Run

The short-run analysis with all factors variable except plant size is summarized in table 4. Schooling costs were represented by a segmented version of the curve depicted in figure 2. Model 4 is distinguished from model 3 in that student numbers were projected to 1984.[13] Model 5 was run under assumptions of 1984 student numbers and a 200% increase in fuel costs.[14]

The consequence of constraining school size only by existing plant capacity was a savings in total cost between model 1 and model 3 of approximately $28,000 or roughly

[13] Student numbers were projected to increase in the eastern part of Lincoln County due mainly to population pressure from adjacent Spokane County. The remainder of the county was projected to decrease in student population.

[14] Both student numbers and fuel costs for transportation were varied parametrically to represent what were felt to be likely alternatives in future years. The 200% increase in fuel cost is based on 1972–73 fuel prices. Since nearly 60% of that increase had occurred by the 1974–75 school year, use of 200% as an upper bound may have been too conservative.

Table 4. Minimum Schooling and Transportation Cost in the Short Run: Schools Constrained to Present Capacity

	Model 3			Model 4[a]			Model 5[b]		
Schools	Student Numbers	Cost of Transportation	Schooling Cost	Student Numbers	Cost of Transportation	Schooling Cost	Student Numbers	Cost of Transportation	Schooling Cost
Almira	129	$ 11,635	$ 143,207	88	$ 7,539	$ 106,181	106	$ 24,733	$ 124,143
Creston	148	13,120	158,955	131	9,531	144,865	137	24,260	149,838
Davenport	534	77,220	403,192	548	158,728	385,496	459	223,324	408,860
Edwall							31	5,199	40,331
Harrington	158	12,254	167,244	148	11,387	158,955	180	41,245	185,479
Odessa	408	63,184	323,507	360	56,284	296,479	353	103,471	292,635
Reardan	475	120,681	365,880	475	115,514	392,429	475	231,027	312,780
Sprague	144	13,801	155,640	146	16,806	157,298	172	55,388	178,848
Wilbur	446	67,675	347,539	400	62,290	318,448	383	109,666	309,111
Subtotals	2,442	$379,570	$2,065,164	2,296	$438,080	$1,960,152	2,296	$818,313	$2,002,025
Total costs		$2,444,734			$2,398,231			$2,820,338	

[a] Student numbers projected to 1984.
[b] Student numbers projected to 1984. Fuel costs increased 200% over 1972 costs.

1% of the total schooling and transportation budget. An example of the change in school district boundaries associated with the solution to model 3 may be found in figure 3. The most significant change was the closure of the Edwall school. These students were sent to Davenport and Reardan. One school, Reardan, was expanded to capacity.

When student numbers were projected into the future, least-cost solutions showed Davenport to be the only school significantly increasing in enrollment. The reason was that considerable population and student growth was expected in Reardan. Since Reardan was in the solution at the capacity, increasing enrollment in Davenport was the least costly alternative.

When both transportation costs and students were projected, the least-cost solution indicated that no schools should be closed. Edwall came back to life with an enrollment of 31 students. However, as a practical matter, Edwall would probably be closed. In general, larger schools drawing from relatively large geographic areas tended to lose their appeal. Davenport for example, decreased from 548 students in model 4 to 459 students under model 5.

Findings: Long Run

The long-run analysis with all factors including plant size considered variable is summarized in table 5. Model 6, like model 1, describes the present condition of school size, student location, and transportation. However, in model 6, unlike model 1, all costs of

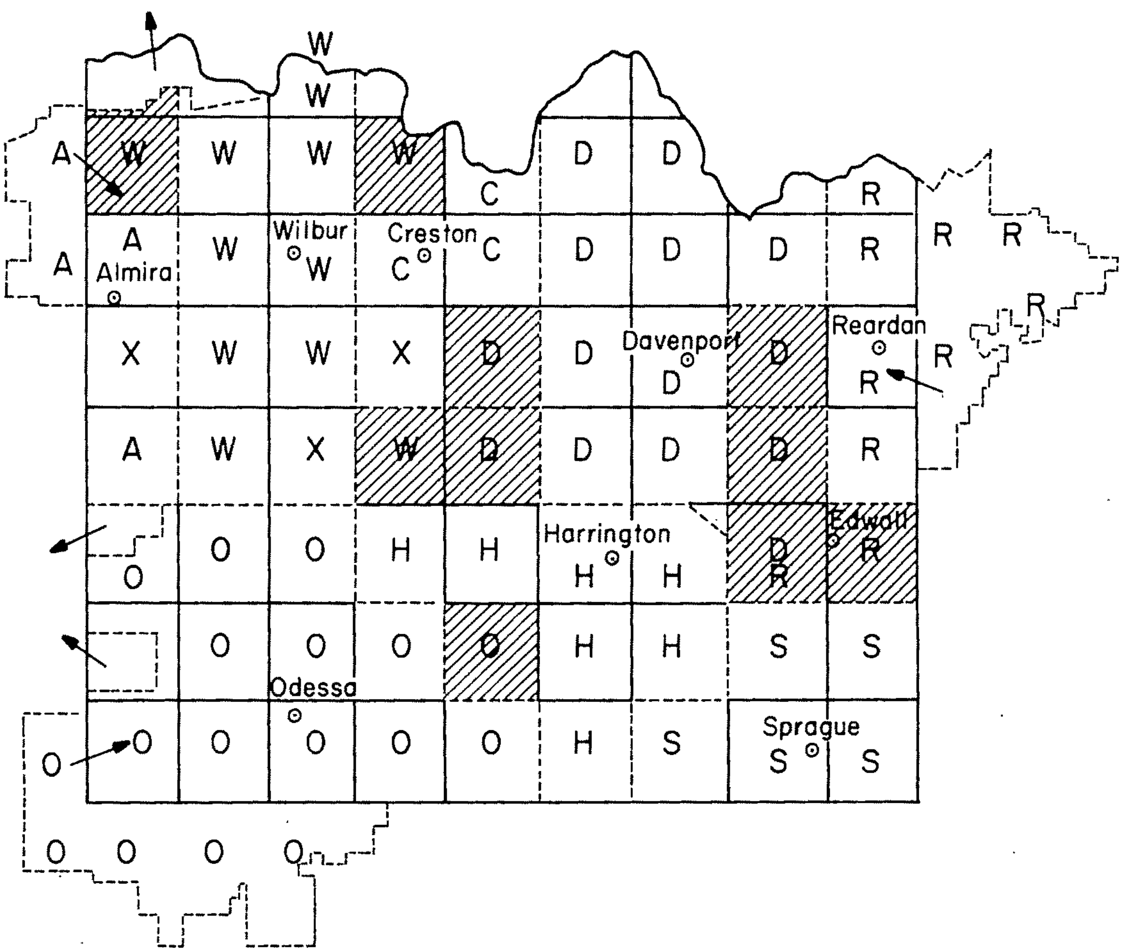

Figure 3. Optimal school district boundaries: schools constrained to capacity. Dashed lines represent existing school district boundaries. Shaded townships represent areas where boundary changes occurred. No public school students reside in townships containing X's.

Table 5. Minimum Schooling and Transportation Cost in the Long Run: School Size Variable

	Model 6			Model 7			Model 8[a]		
Schools	Student Numbers	Cost of Transportation	Schooling Cost	Student Numbers	Cost of Transportation	Schooling Cost	Student Numbers	Cost of Transportation	Schooling Cost
Almira	162	$ 22,589	$ 193,724	129	$ 11,635	$ 161,778	106	$ 24,733	$ 139,513
Creston	164	17,979	195,705	148	13,120	180,216	137	24,260	169,567
Davenport	457	44,327	416,488	485	57,014	437,727	400	85,561	373,252
Edwall	76	12,068	104,278				31	4,456	44,887
Harrington	187	23,796	217,925	158	12,254	189,851	165	34,099	196,628
Odessa	397	58,079	371,215	408	63,184	379,320	353	103,471	341,348
Reardan	453	104,343	413,454	524	139,526	467,309	583	349,852	512,062
Sprague	144	13,801	176,299	144	13,801	176,299	138	26,186	170,490
Wilbur	402	49,294	374,769	446	67,675	408,144	383	109,667	361,712
Subtotals	2,442	$346,276	$2,463,857	2,442	$378,209	$2,400,644	2,296	$762,286	$2,309,460
Total costs		$2,810,133			$2,778,853			$3,071,747	

[a] Student numbers projected to 1984. Fuel costs increased 200% over 1972 costs.

schooling are based upon the long-run curve. Model 6, therefore, provides the frame of reference for comparisons under a long-run planning horizon. Model 7 represents current enrollment and fuel costs. In model 8, enrollment and fuel costs were projected into the future.

Cost savings associated with model 7 were approximately $31,000 as compared to model 6. Transportation costs were increased $32,000 while schooling costs decreased by approximately $63,000. As in the short-run solution, Edwall was closed, but it was the only school closed. Most schools remained near their present size. Although Reardan was the largest school, it was expanded to an enrollment of only 524 students.

Under the changes projected in model 8 (future student numbers and transportation costs), total costs were increased even though student numbers were reduced and plant size was optimal. No schools were eliminated but Edwall was operated at very small enrollment.

Conclusions

The objectives of this study were to investigate the relationship between internal schooling economies and transportation costs with regard to the question of rural school consolidation and to test the usefulness of separable programming in such an investigation.

While public schooling does seem to be characterized by size economies, consolidation cannot be counted on to provide large cost savings in sparsely populated rural areas. In both short-run and long-run models, cost savings were equal to only approximately 1.3% of the annual schooling and transportation budget.

Also, it should be pointed out that these estimates place no value on children's commuting time. If only a nominal value is assigned as the opportunity cost of farm children's time, these estimates represent an upper limit to the true savings available from consolidation. Depending upon how community pride and viability are affected by the disruption caused by boundary changes and the closing of schools, the correct decision in Lincoln County and other similar rural areas may be not to consolidate presently existing schools.

It is also quite clear that the energy crisis is on the side of the small, rural school. As transportation costs rise, a very likely prospect in future years, small schools become increasingly attractive. Plans for eliminating small rural schools as a move toward more efficient use of resources may prove to be very shortsighted.

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The Economic Impact of Controlling Nonpoint Pollution in Hardwood Forestland

W. L. Miller and H. W. Everett

This research examines the economic impact of controlling sediment loss through changing forest management practices, harvest methods, and rates of harvest. A comparison is made between the income foregone to forestry firms and the regional loss of income as alternative measures of the cost of pollution control. Both measures indicate substantial losses result from controlling nonpoint pollution and suggest present projections of this cost underestimate true social losses.

Key words: benefit-cost, pollution, input-output.

Legislation mandates the development and implementation of plans to control nonpoint pollution (U.S. EPA 1974). Developing adequate and cost-effective policy to achieve control of nonpoint pollution requires substantial analytical data about the impact of alternative control methods. A broad spectrum of alternate methods should be examined to be certain the most useful ones are identified for analysis. As alternative methods are examined, questions develop about the appropriate measurement procedures when considering alternative methods to control nonpoint pollution in hardwood forest areas.

Water quality legislation and previous research have indicated several water quality parameters which might be measured to establish indices of environmental quality (Miller and Byers). Although there are several water quality parameters which could be examined in forested areas, sediment is the major single source of pollution in these areas (U.S. EPA 1973). Therefore, this research examines the economic impact of alternative methods to control sediment alone rather than examining an index of water quality containing several parameters. It should be noted that methods which contribute to a reduction in sediment pollution may reduce nutrients and other nonpoint pollution parameters also (Miller and Erickson).

The specific objectives of this research are to examine the economic impact of forest management practices, harvesting methods, and rates of harvest which could be introduced to reduce the sediment loss from forest land and to compare alternative measures of the economic impact resulting from these practices and methods to control nonpoint pollution.

A unique situation in southern Indiana provides a locale for the collection of empirical data to complete the objectives of this study. Four counties known as the Lincoln Hills Resource Conservation and Development Area are working together to improve and develop their forest resources. Citizens in this area have expressed a need for information about their forest resource and its development. Consequently, this area was selected as a case study location to complete these research objectives.

Previous Research

Research work related to this study can be divided into two groups. The first group involves the theoretical issues about the measurement of economic impact. The second group includes methodological applications of the models used here to similar problems.

Presently, many reports on the cost of pollution control have dealt only with the directly

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incurred costs of introducing or installing the new technology to reduce pollution. For example, the Council on Environmental Quality presents data based primarily on cash expenditures for the capital and operating cost of construction and equipment required for pollution abatement when presenting dollar estimates of pollution abatement costs (U.S. Council on Environmental Quality). Most popular articles cite the cost of building sewage treatment plants as the major cost of cleaning up rivers.

In the case of nonpoint pollution those measures of cost are inappropriate since the control must be achieved through altering land use and land management practices. The social cost of controlling nonpoint pollution is the income foregone (opportunity cost) of introducing the pollution control technology. For example, to reduce sediment in streams that comes from nonpoint sources it may be necessary to shift from row crop products to timber products on a sloping hillside that has a serious erosion problem. The income foregone by substituting timber for row crops is the direct loss to a farmer for nonpoint pollution control. Since the opportunity cost concept is developed adequately by others, it will not be discussed in detail here (Ferguson).

It is important to identify and measure the appropriate income foregone when assessing the cost of controlling nonpoint pollution. Should the cost measured include only the direct changes in income that occur when adopting nonpoint pollution control technology or is a more appropriate measure the total change in regional income? There is a general agreement with the measurement of direct changes to assess economic impact; it is the essence of the benefit-cost analytical framework (and the economic account measurement used in multiple objective planning) (Bromley, Butcher, and Smith). However, economists have been extremely careful in the past application of benefit-cost analysis to avoid errors of double counting and/or mistaking regional income increases as national benefits. The only exception is that regional impact has been measured as national benefits when unemployment has existed in the region. A decade ago, Stoevener and Castle made this point forcefully. More recently Hanke has reiterated that position.

We believe an argument can be made for utilizing the regional income changes as the appropriate measure of economic impact when controlling nonpoint pollution. This control takes land inputs out of production and/or reduces the productivity of those still in use. Therefore it creates "unemployed" land resources which are a direct loss of output to society, not a regional transfer. Since land is not mobile, it cannot be transferred to another region. Symmetry in the unemployed resource argument would require that if regional income change is an appropriate measure of benefit when unemployment is reduced, then it is an appropriate measure of cost when employed resources are created. We are supported in this position by other recent work; for example, a study by the Organization for Economic Cooperation and Development states: "Fundamentally, what would happen [through pollution control] is that productive resources would be shifted away from the production of the non-environmental goods and services which enter GNP as traditionally measured and used to increase the output of environmental 'goods' (clean air, clear water) which are not considered to be part of traditional GNP" (p. 36). In addition, Lewis et al. present a persuasive argument for measuring both direct and indirect effects of water resources development.

Whether the direct or the regional income change is accepted as the appropriate measure of economic impact, this research shows that presently the cost of nonpoint pollution control is underestimated because it only includes the cost of treatment plant construction excluding either the direct or regional income changes that would occur through nonpoint pollution control. It is only the magnitude of that underestimation which is at issue when considering whether direct or regional income is the most appropriate measure.

Theory and Method

The economic analysis is based upon the neoclassical static microeconomic model. It includes the usual assumptions associated with firm theory, e.g., perfect competition prevails in both factor and product markets. In addition, certain assumptions of additivity, divisibility, and linearity are introduced into the research as a result of the specific form of the empirical models which are utilized to analyze the problem.

In order to compare alternative measures of the economic impact, two models were de-

veloped; one analyzed the direct change in income to forestland owners and the second analyzed the regional income change. The direct change in income to forestland owners was examined with a linear programming model designed to maximize the present value of net revenue to the forest sector subject to the soil loss and harvest volume constraints. Six major forest types typical of the Lincoln Hills area were included in the model. These were loblolly shortleaf pine, oak-pine, oak-hickory, oak-gum-cypress, elm-ash-cottonwood, and maple-beech-birch. The present value of net revenue from management and harvesting of these forest types was developed for a fifty-year planning horizon that was further subdivided into five ten-year periods. Eight different management and harvest alternatives were included for each forest type in the multiperiod model. The eight alternatives were clear-cutting with or without forest management, group select cutting with or without forest management, unharvested growing stock with or without forest management, planting of trees, and the regeneration of trees. The linear programming model is specified below:

$$\max z = \sum_{i=1}^{5} \sum_{j=1}^{n} c_{ij} x_{ij} \qquad j = 1, \ldots, 48,$$

subject to:

$$(1) \quad \sum_{j=1}^{n} s_{ij} x_{ij} \leq b_i \qquad i = 1, \ldots, 5$$

$$(2) \quad \sum_{j=1}^{n} d_{kj} x_{ij} \leq b_k \qquad k = 1, \ldots, 5$$

$$(3) \quad \sum_{j=1}^{n} a_{ij} x_{ij} \leq b_g \qquad g = 1, \ldots, 5$$

$$(4) \quad x_{ij} \geq 0$$

where z = present value of total net income to landowner and manager, c_{ij} = discounted net income per acre per year of the jth activity in the ith period, x_{ij} = acreage of the jth activity in the ith period, s_{ij} = amount of soil loss in tons per acre per year of jth activity, b_i = maximum soil loss measured in tons per year, d_{kj} = number of board feet of timber harvested per acre under jth activity, b_k = maximum number of board feet to be harvested under all activities for the kth period, a_{ij} = transfer and accounting coefficients which direct movement of the jth activity in one period to the jth activity in the next period, and b_g = transfer and accounting constraints which affect movement of each activity from period to period, e.g., land harvested in one period is not available for harvest again until a sufficient number of periods have been completed to allow regrowth of the timber.

Analysis with this model involves ranging the limit of soil loss permitted in the constraint (b_i) to establish the present value of net revenue that would occur for different levels of nonpoint pollution. When this analysis was completed, the sensitivity of the model was examined using other parameters, such as the rate of harvest and the discount rate. The output of this model was linked to a second economic model in order to relate the changes in level of nonpoint pollution to both sectoral and regional economic impact.

The second model was a twenty-seven-sector regional input-output model for the Lincoln Hills area. The utilization of this model involved the development of a transactions table or technical coefficients table which represented the economy of the four-county case study area. Once developed, the interdependency coefficients were calculated for the model. This model was "closed," that is, the households sector was included in the processing sector. Sector output multipliers were calculated for forestry-related sectors of the model.

Linking the two models involved some modification of the output of the linear programming model before it could be introduced into the input-output model. It was necessary to relate the output from the fifty-year linear programming model to the annual input-output model. The procedure for relating the two began by obtaining the solution value for each activity (x_{ij}) in the first ten-year period. These solution values were then multiplied by the respective gross discounted revenue or cost associated with each activity. This result was divided by 10 to get the average annual gross discounted revenue. Finally, the estimated intermediate output of the forest sector of the input-output model was subtracted from each of the average annual gross discounted revenue figures in order to calculate the estimated final demand(s) of this sector.

The differences between each of these estimated final demands are used as changes in final demand in the input-output model. Through the multiplication of these final demand changes by the output multiplier and the

Type II income multiplier of the forest resource sector, determination can be made of the regional economic impacts (Miernyk).

Data

Data were collected from secondary sources to represent as closely as possible the forest resource situation in the Lincoln Hills area. Initially it was necessary to establish the price and cost coefficients for the objective function of the linear programming model. All data pertaining to acreage, species, quality, and yield from timberland were obtained from Spencer. Other data were collected from secondary sources on yields per acre for verification of yields estimated from this source. Prices by species and grade were obtained from an annual price report on Indiana forest products for the southern half of Indiana (Cooperative Extension Service). Cost estimates for the management practices, harvesting methods, and hauling of timber were developed from secondary sources (Kinne, USDA Forest Service).

The sediment data for the constraint in the linear programming model were developed using standard hydraulic techniques. Estimates of soil losses from woodland in Lincoln Hills were made using the universal soil loss equation and the "C" factor adopted for woodlands (Wischmeier, Wischmeier and Smith). This is consistent with the procedure recommended by Dissmeyer. Specific soil types and slopes were taken from soil surveys made of Perry and Spencer Counties and were used to apply over the entirety of Lincoln Hills. These data were utilized because there were no complete detailed soil surveys available for the other two counties. Soil losses varied by management practices and harvest methods.

The data for the harvest constraint were derived from Spencer. The volume to harvest over the fifty-year planning horizon was developed for two different scenarios. The first scenario, called declining rate of harvest, allowed a large harvest the first ten-year period to reduce the volume of poor quality timber. This was followed by a lower constant volume harvested in the subsequent four ten-year periods which was about equal to the growth rate during those periods. The second scenario, called increasing rate of harvest, allowed harvest volumes based upon the estimated market share of the Lincoln Hills area in the growing national market for timber. It involved harvest in the first period at about the rate of growth during that period with a constant rate of increase until in the fifth period about twice the initial volume of timber would be harvested. Figure 1 indicates the limits in the volume of timber harvested each period for these two scenarios.

Two acreage assumptions were utilized in the analysis. The high acreage assumption includes 393,024 acres in Lincoln Hills as commercial forest land (USDA Soil Conservation Service). This acreage probably overstates the land that would be directly affected through nonpoint pollution control because it includes small tracts which may not be managed primarily for economic return from timber production. Research by Frutchey and Williams indicates small woodlot owners may have many other motivations for holding land than maximizing economic returns. Therefore, a low acreage assumption was used to reflect the acreage that would probably be directly affected by nonpoint pollution control regulations. This 146,661 acre assumption was obtained from the 1969 Census of Agriculture for the Lincoln Hills area. It is about 37% of the total acreage estimated in the Conservative Needs Inventory (USDA Soil Conservation Service).

Data for the input-output analysis were obtained from an input-output study of Perry and Spencer Counties (Reimer) which are two of the four counties comprising Lincoln Hills. The technical coefficients of the Reimer study, which were developed by direct survey methods, were compared to the technical coefficients of a second regional input-output study (Green) done in the same area of southern Indiana which includes all of Lincoln Hills and several other counties. The coefficients of the two studies were similar in magnitude for each sector; therefore, it was assumed that the coefficients of the Reimer study would apply equally well to the four-county area studied in this model. This assumption is supported further by observing that the distribution of employment among the sectors of the two counties included in the Reimer study is similar to the distribution of employment among the sectors of the other two counties in Lincoln Hills.

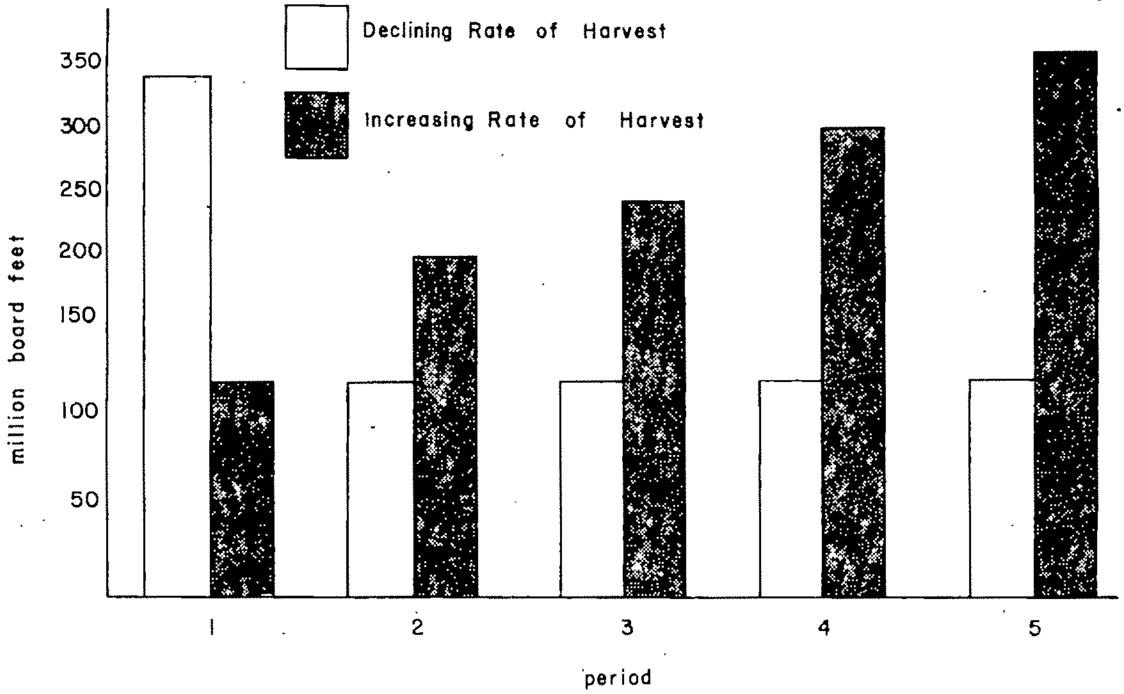

Figure 1. Limits on harvest volumes per period for increasing and declining rates of harvest

Results

The results of the analysis are presented in three major sections. The first section examines the reduction that occurs in sectoral income as the soil loss constraint level permitted is reduced, i.e., specification of lower nonpoint pollution levels. These results are presented and compared for 6% and 12% rates of discount and for high and low acreage assumptions. The second major section examines the sensitivity of the sectoral income solutions to variations in the rate of harvest scenarios. The third major section presents the results of the alternative measure of cost, i.e., the changes in regional income which result from controlling nonpoint pollution.

With the declining rate of harvest scenario under the high acreage assumption and utilizing a 6% rate of discount, the present value of net revenue ranged from a high of $5,614,008 when soil loss was not a binding constraint to a low of $3,616,407 when soil loss was held to the minimum feasible level (164,980 tons per year) in this model. The effect of constraining the objective function by reducing soil losses clearly results in a shift from activities where timber is not managed to activities where timber management is practiced.[1] Although the gross revenue derived from the cutting activities under timber management is higher than for unmanaged timber, the net revenue is lower due to the cost of fencing to exclude livestock, the cost of fire control, and the loss of the value of the grazing. However, the improved erosion control when timber is properly managed brings the managed activities into solution when the sediment constraint is made progressively more severe. This explains why the managed activities did not come into the optimum unconstrained economic solution but are forced in to reduce the loss from the land sediment. Under this harvest constraint clear-cutting was the most profitable method to harvest the timber. As the soil loss constraint was made more restrictive, the clear-cutting was the most profitable method to harvest the timber. As the soil loss constraint was made more restrictive, the clear-cutting was replaced by group selection harvest.

The next analysis was completed under identical conditions as the first except that a 12% rate of discount was utilized instead of a 6% rate. The differences in solution bases

[1] Management in this case refers solely to the elimination of grazing and control of fires.

were minor enough to consider them as negligible. However, the present value of net revenues were reduced appreciably due to the higher discount rate. With soil losses nonbinding, net revenues amounted to $3,780,742, while the low net revenue figure was $2,524,128 when soil losses were held to a minimum of 164,980 tons per year. The results of reducing the soil losses are indicated in table 1.

Changing the harvesting scenario from a declining rate to an increasing rate resulted in large differences in solution bases of the model. The differences are mainly in the acreages of timber cut per period rather than the forest types which entered the optimum solution. These differences in acreage cut per period result in lower net revenues for the increasing rate of harvest scenario. For example, with a 6% rate of discount and soil losses nonbinding; the declining rate harvest generates $5,614,008 in net revenue while the increasing rate harvest generates only $4,179,766. Though the increasing rate harvest yields more board feet of timber than the declining rate harvest over the fifty-year planning horizon, the latter generates higher net revenues because it calls for a first period cut of timber three times as large as the former. This difference in revenue occurs because the value of timber harvested in the earlier periods is reduced less by the discounting factor than that harvested in later periods.

The results of analysis of the low acreage assumption are presented in table 2. These results are consistent with those presented above and simply reflect the reduction in acreage from 393,024 acres to 146,661 acres. These results indicate more accurately what would probably happen in Lincoln Hills, where some of the forest land is not being managed to optimize income from timber sales.

While this economic measurement of the effect of soil loss levels on income is an often used and valid approach to impact analysis, an alternative economic measurement provides additional, somewhat different information about the impact of water pollution control. The results of the input-output model developed for analysis of the regional change in income, i.e., the direct, indirect, and induced income changes, are presented in table 3. When the forest resources sector is unconstrained by water pollution control regulations, it contributes substantial regional income to the Lincoln Hills area. This impact amounts to $1.44 million annually which can be directly compared to the average annual direct income impact of $0.06 million (derived from dividing the net present value for the fifty-year planning horizon presented in table 2 by 50). Clearly, utilizing the regional impact to measure the contribution of the forest sector results in a much larger economic impact than is identified in the direct income analysis. Therefore, the economic consequences of reducing soil loss are considerably greater when regional income change is used as the measure of economic impact.

This conclusion is illustrated by the data presented in table 3. As the economic activity is constrained by placing limits on soil loss at 106,280 tons per year, the regional economic impact is reduced to $1.4 million annually. The annual reduction in regional income that occurs as soil loss declines from 156,280 to 106,280 tons per year results in a $0.76 reduction in income to the region for each ton reduction in soil loss. As the permitted soil loss level is reduced further to 56,280 tons per year, regional income is reduced about $1.4 million more annually or about an additional $28 annually for each ton reduction in soil loss. The final demand for the 56,280-ton level is calculated by subtracting the output requirement of the forest resource sector with an initialized zero final demand from the annual gross revenue data from the linear programming model. Since the internal level of output requirements for the forest resource

Table 1. Present Value of Net Revenue under the Increasing and Declining Rate of Harvest Scenarios, High Acreage Assumption, Lincoln Hills, 1974

Soil Loss (tons/year)	6% Discount		12% Discount	
	Declining Rate	Increasing Rate	Declining Rate	Increasing Rate
364,980+	$5,614,008	$4,179,766	$3,780,742	$2,231,470
264,980	5,102,995	3,698,739	3,440,981	1,949,437
164,980	3,616,407	2,842,543	2,524,128	1,485,930

Table 2. Present Value of Net Revenue under the Increasing and Declining Rate of Harvest Scenarios, Low Acreage Assumption, Lincoln Hills, 1974

Soil Loss (tons/year)	6% Discount		12% Discount	
	Declining Rate	Increasing Rate	Declining Rate	Increasing Rate
156,280+	$2,964,988	$2,383,099	$2,329,258	$1,628,386
106,280	2,753,144	2,209,134	2,166,952	1,513,981
56,280	1,213,024	1,213,024	798,942	798,942

sector exceeds the annual gross revenue at the 56,280-ton level, all entries in that line of table 3 are zero.

It has been demonstrated that the magnitude of the loss in regional income greatly exceeds the direct revenue loss as water pollution levels are reduced. It should be noted that the direction of change in this analysis is consistent between the regional and sectoral measures of economic impact, i.e., both decline as soil losses decline. Although that consistent pattern was expected in this forest study, there is no a priori reason why that pattern would have to occur in other empirical research.

Policy Implications

Controlling nonpoint pollution results in substantial economic impact both to the firms directly affected and in the region. The cost of pollution control has often been measured by only considering the dollar expenditures on pollution control equipment such as wastewater treatment plants. The opportunity cost of income foregone is the appropriate measure of the cost to society for introducing various nonpoint pollution control measures because it takes into consideration the sacrifice in income that results from controlling pollution. The income foregone in the Lincoln Hills area at various levels of sediment control was measured by two different economic models. Although these two models both had substantial dollar values, the regional economic impact was about twenty-three times greater than the direct impact. Therefore, it becomes extremely important in assessing the magnitude of the dollar economic impact of nonpoint pollution control which of these models is selected to measure it. Currently, the cost of controlling nonpoint pollution is being greatly underestimated. It is suggested here that the regional impact may be a more appropriate measure than the direct impact. Certainly its use should receive increasing attention and further research.

Suggesting the use of improved measures of the economic impact of nonpoint pollution control in no way suggests a change in present national goals to achieve improved water quality. Better measurement can provide the opportunity for improved policy decisions about the appropriate level of water quality to plan toward. It may suggest altering methods or approaches to achieving the goals through adoption of policy, e.g., management techniques or harvest methods which contribute the least to reducing income while meeting the water quality levels deemed desirable. Furthermore, there is substantial need for improved measurement on the benefit side of water pollution control especially since the

Table 3. Indirect Economic Effects of Controlling Nonpoint Pollution (in $1000.)

Soil Loss (tons/year)	Estimated Final Demand[a]	Added Interindustry Output[b]	Direct Income Change	Direct, Indirect and Induced Income Change[c]
156,280	$934	$4,175	$848	$1,441
106,280	910	4,066	825	1,403
56,280	0	0	0	0

Note: This table is based on a declining rate of harvest, the low acreage assumption, and a 6% rate of discount.

[a] This is the change from zero final demand.

[b] The total added interindustry output needed to support final demand. It equals the estimated final demand multiplied by the output multiplier of 4.47.

[c] This is the direct income change multiplied by the Type II income multiplier of 1.70.

externalities associated with pollution activity are diffuse, difficult to measure, and often entail determining values of public goods.

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Disaggregation of Input-Output Models into Product Lines as an Economic Development Policy Tool

James R. Simpson and John W. Adams

A method of determining output and income multipliers for product lines by disaggregating sectors of either the transactions or technical coefficients matrix in existing input-output studies is presented. The study focuses on beef exports from Argentina, Brazil, Paraguay, and Uruguay. The analysis indicates that canned and cooked/frozen beef, while generally considered low quality or inferior products are, in terms of economic impacts on the economy, actually "high quality" products. An application of the analysis to planning in Uruguay is presented. Direct and indirect effects from different export product mixes are estimated and projections made to 1985.

Key words: economic development, multipliers, input-output, beef, South America.

Beef export policy and the development of a viable beef industry have been the focus of technical assistance and national planning in many Latin American countries for over twenty-five years (Breimyer, USDA, UN 1970). At least eight input-output (I-O) studies have been constructed in the past fifteen years (UN 1970), but it is often difficult to assess the impact of the beef export industry from I-O models that treat the beef industry as a single sector. The basic problem results from the possibility of specializing in exporting different product lines. For example, the Central American countries have traditionally shipped chilled or frozen beef and have done little processing. The South American countries, on the other hand, have exported the entire gamut, live animals, sides of beef, and canned corned beef. To capture the impact of this potential diversity, it is desirable to reconstruct the I-O matrix along product lines, a process which is often difficult and is not widely reported in the literature.[1]

The purpose of this paper is to demonstrate how information from personal interviews with beef packers can be combined with existing disaggregation techniques to develop I-O models based on product lines. An application is made to the beef export industry of Latin America. Policy implications are made that would not have been possible in a model where the beef industry was considered as a single production sector.

The study focuses on Argentina, Brazil, Paraguay, and Uruguay because of the diversity of their beef export sectors. However, the analysis should have some relevance to other Latin American countries. The exports studied include live cows, bone-in beef quarters, frozen boneless manufacturing beef, and cooked frozen and canned beef. The analysis is limited to cow beef since the methodological complications of including steer beef are substantial.[2] An application to planning in Uruguay is given as a final section.

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[1] There have been a few studies in which researchers have evaluated new industries in developed countries (Adams; Miernyk and Shellhammer) but the possibility of disaggregating existing industries into product lines does not seem to have been researched either in developed countries or in LDCs.

[2] The problem is that steers, although comprising the majority of all the above beef exports, are almost always broken down into numerous wholesale cuts which depend on market conditions and customer's orders at the time of slaughter. In contrast, an entire cow is frequently directed entirely, or almost entirely, to one of the four product forms listed. Thus, restricting the analysis to cow beef is a vehicle for simplicity in preparation of budgets used in the disaggregation process.

Multiplier Estimation Procedures

The first step in obtaining the product line multipliers was to interview beef packers in the four study countries.[3] The data obtained were sufficiently detailed to permit the construction of a cost and returns type economic model for each of the four beef products and live cows. A 1400-head capacity, fully integrated packing plant was considered "typical" and served as the base. The items in the initial models were then redistributed on an interindustry (sector) basis. Since the revised cost and returns models were inserted into four different South American I-O studies, four slightly different models were required.

Two Argentine studies (1963 and 1970), one for Brazil (1959), and one for Uruguay (1961) (Argentina, Banco Central; Argentina, Secretaria de Planeamento y Accion de Gobierno; Ellis; Universidad de la Republica) were chosen as base I-O studies because a general statement relevant to all of the major beef-exporting countries was desired. This procedure also provided a reliability test of the disaggregation method. An example of one model (for Argentina) is given in table 1. The adjusted budgets are based on a ton of product but, for use in the I-O studies, are considered to be a year's transactions for the whole economy.[4]

The method for expanding (opening up) the transactions matrix and inserting the coefficients for the four processed products can be described algebraically. Each of the transactions for all four new products were summed for one row and subtracted from the original cell value. The residual was assumed to be the transactions for all other products in the meat-processing industry. The subtracting procedure was carried out in the same manner for all other rows insuring the transactions matrix remained completely balanced, that is, the gross output of sector i, x_i, of the original model is given by

$$x_i = \sum_{j=1}^{n} x_{ij} + D_i,$$

where x_{ij} = sales from sector i to j and D_i = final demand for sector i's output. Then, assuming that sector N is the sector to be disaggregated, we can write the gross output of sector $i (i = 1, \ldots, n-1)$ as

$$x_i = \sum_{j=1}^{n-1} x_{ij} + x^*_{in} + \sum_{j=n+1}^{n+4} x_{ij} + D_i,$$

where x_{n+k} = kth product line sector and

$$x^*_{in} = x_{in} - \sum_{j=n+1}^{n+4} x_{ij}.$$

For the new sectors, gross output can be written as

$$x_{n+k} = \sum_{j=1}^{n-1} x_{ij} + x^*_{in+k} + \sum_{j=n+1}^{n+4} x_{ij} + D_{n+k}$$

and for the sector x^*_n (the residual after the product lines have been taken out), gross output can be written as

$$x^*_n = \sum_{j=1}^{n+4} x^*_{ij} + D^*_n,$$

where $$x^*_{ij} = x_{ij} - \sum_{i=n+1}^{n+4} x_{ij}$$

and $$D^*_n = D_n - \sum_{i=n+1}^{n+4} D_i.$$

The well-known multiplier derivation techniques were then followed to obtain the product line income and output multipliers.[5] The same procedure was used to obtain multipliers for live cow exports except that the livestock sector was disaggregated in this case.[6]

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[3] This was carried out in July and August of 1973 when two large international packers in Paraguay, three in Argentina, three in Uruguay, and one in Brazil were contacted.

[4] For example, the $622.78 purchases by the subindustry bone-in beef quarters from the agriculture sector were simply retitled 622.78 million Argentine pesos. Budgets for other countries are available from the authors.

[5] Rather than inserting budgets in the transactions matrix, each item can be divided by the total to obtain the technical coefficients. These coefficients can be integrated into the technical coefficients matrix to obtain multipliers (Adams 1973). In this study it was done for the 1970 Argentine study in which the technical coefficients matrix had been updated from the 1963 study by a dynamic procedure. No 1970 transactions matrix is available. Detailed discussions on multiplier derivation have been presented by Chenery and Clark; Leontief; Miernyk; Simpson (1974).

[6] I-O studies for a number of the Latin American countries were constructed by the UN Economic Commission for Latin America in the late 1950s and early 1960s (Chenery and Clark, chap. 13). A more complete discussion of I-O models in Latin America has been prepared by the commission (1973) in Santiago, Chile. A preliminary report has also been prepared by the UN Economic Commission for Latin America. Detailed discussions of I-O model application have been developed by Barna; Ghosh; Hirsch; Maki; and Rasmussen among others. The planning application is generally on import substitution or the very macro level. It does not appear that studies on application to decision making for a specific industry in an LDC have been published.

Table 1. Estimated Cost and Sales Data for Beef and Beef Products, Disaggregated 1963 Argentine I-O Study, Product Weight Basis

Sector Number	Sector or Item	Bone-in Beef Quarters	Frozen Boneless Manufacturing Beef	Cooked/ Frozen Beef	Canned Beef	Live Cow Exports
		$				
1	Agriculture	622.78	865.15	1075.89	966.75	302.11
3	Food and beverages				22.89	
4	Textiles	8.59				
5	Ready-made wearing apparel	1.01	5.26	7.59	14.00	
6	Wood		1.00	1.00	2.00	
7	Paper and cartons		19.67	12.23	23.73	
10	Chemical				.12	
11	Petroleum	16.27	24.07	22.27	15.84	
13	Metals				6.40	
14	Machinery	3.16	5.00	7.43	10.00	
17	Various		4.05	23.35	3.00	
20	Commerce	13.57	26.65	41.66	38.37	
21	Transportation and storage	11.47	17.43	18.26	9.15	23.87
23	Services	18.49	27.48	34.49	35.03	2.90
	Subtotal	695.34	995.76	1244.17	1147.28	328.88
	Value added					
	Labor	36.75	138.45	199.73	235.91	13.09
	Profit	160.31	−33.73	835.37	177.02	6.47
	Subtotal	197.06	104.72	1035.10	412.93	19.56
	Other					
	Depreciation	23.87	27.28	42.66	64.00	
	Customs	4.03	4.03	4.03	14.92	4.03
	Defective cans				.50	
	Export taxes	565.64	650.72	865.59	634.31	347.53
	Subtotal	593.54	682.03	912.28	713.73	351.56
	Imports					
	Subtotal	12.00	17.54	31.72	104.80	
	Total gross outlays	1497.94	1800.05	3223.27	2378.74	700.00
	Gross output (sales)					
	Major item	1448.00	1593.40	2922.00	2043.00	700.00
	Extract			126.61	177.49	
	High price cuts		72.40	72.40	66.61	
	Trim to canning		46.26			
	Fat		6.47			
	Byproduct credit	49.94	69.33	86.52	77.54	
	Bone credit		12.19	15.74	14.10	
	Total gross output	1497.94	1800.05	3223.27	2378.74	700.00

Source: Simpson 1974.

Because of the differences between the time the I-O studies were originally constructed and the product line budgets were prepared, the implicit I-O framework assumption of constant technology and no change in relative prices was carefully scrutinized. The conclusion is that the assumption is not a limiting factor in this study despite recognition that technological changes over time do affect the pattern of input requirements. The reason for the time period differences not being a constraint is that the study purpose is a compari-

son of several multipliers all of which have been prepared for one sector rather than a comparison with original multipliers.[7]

Application of the Analysis to Planning in Uruguay

The selection of an economic sector or subsector (including product lines) for development stimulation can be based to some extent on the direct and indirect impact from output and income increases.[8] To evaluate the beef products mentioned, the type I (households exogenous) and type II (households endogenous) multipliers were obtained by the method previously explained and are presented in table 2. Greater processing is, as would be expected, associated with higher multipliers. In all studies, the ordering is the same and very little difference is observed in the absolute size within a product line.[9]

Using Uruguay as an example, a $1 million change in final demand for cooked/frozen beef would generate about $4.18 million of output and $1.16 million of income.[10] Canned beef is second with $3.79 million of output and $940,000 worth of income. Quarters and manufacturing are about the same and tie for third.

Demand projections developed elsewhere indicate potential for exploitation of any export mentioned above (Simpson 1973, 1974). Since any one of the exporting countries' future share of each product is impossible to determine, a hypothetical situation can be created to evaluate several alternatives which a country might face. It also provides an illustration of how the product line multiplier analysis can be used in policy making. A nation which lends itself well to exposition of this type of analysis is Uruguay where exports of canned beef have declined rapidly over the past decade.[11]

Three export policy models for Uruguayan beef are presented in table 3. The first model assumes the product mix prevailing in the early 1970s where bone-in quarters make up

[7] The two principal factors which affect multiplier size are international beef price and, as a direct result of it, prices paid to farmers. As can be seen in table 1, the animal itself represents about 35%–50% of the total product cost. Although these prices do change considerably over time, a sensitivity test indicated no significant differences in the multipliers when the international price of beef was reduced by as much as 30%. Changing other major costs such as labor, cow purchase price, tinplate, and taxes also had little effect. In no case did the ranking of product line multipliers change.

[8] A discussion of employment multipliers would be desirable especially given the relatively high unemployment (or at least disguised unemployment) rates in the countries studied. This was not possible, however, due to the aggregated nature of the employment data. Furthermore, only the 1963 Argentine study had wages and salaries, which are needed for estimation of the type II multiplier, separated out.

[9] An estimating procedure was used to separate wages and salaries (the labor part of "households") from "other." This is acceptable since the purpose is comparison of multipliers between product lines. Testing of different percentage applications did not reveal significant (at the second decimal place) differences in the product line multipliers, i.e., they all varied up or down about the same.

[10] The direct income effect multiplied by change in output gives the direct change in household income for the sector under analysis. Multiplying that times the type II income multiplier (table 2) yields the direct, indirect, and induced income change. For a complete discussion see Simpson (1974).

[11] Apparently this is due to instability, a general reluctance by government to encourage this industry, and concern about demand for the heavily processed products.

Table 2. Output and Income Multipliers for Export of Beef and Beef Products, Disaggregated I-O Studies

	Live Cows		Bone-in Quarters		Frozen Boneless Manufacturing		Cooked/ Frozen		Canned	
	Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type II
Output multiplier:										
1963 Argentina	1.73	3.33	1.72	4.04	1.86	4.00	1.60	4.87	1.76	4.41
1970 Argentina			1.76	4.04	1.90	4.02	1.63	4.84	1.79	4.40
1959 Brazil	1.62	3.19	1.62	3.76	1.75	3.67	1.52	4.75	1.66	4.17
1961 Uruguay	1.66	3.02	1.65	3.47	1.78	3.44	1.54	4.18	1.68	3.79
Income multiplier:										
1963 Argentina	9.66	20.38	2.78	6.25	5.82	13.10	1.61	3.62	2.41	5.43
1970 Argentina			2.81	6.06	5.90	12.74	1.62	3.49	2.43	5.25
1959 Brazil	8.08	21.83	2.47	6.44	4.90	12.79	1.49	3.90	2.14	5.60
1961 Uruguay	8.98	20.18	2.62	5.51	5.44	11.44	1.56	3.28	2.30	4.84

Source: Simpson 1974.

Table 3. Estimated Uruguayan Beef Exports and Three Hypothetical Output Situations

	Beef Available for Export				Estimated Final Demand[b]				Projected Direct and Indirect Effects[c]			
	Bone-in Quarters	Frozen Boneless Manufacturing	Canned	Total[a]	Bone-in Quarters	Frozen Boneless Manufacturing	Canned	Total	Bone-in Quarters	Frozen Boneless Manufacturing	Canned	Total
	1000 metric tons				$1000							
Model I: quarters, 75%; manufacturing, 24%; canned, 0%[d]												
1975	146.7	48.9		195.6	212,422	81,458		293,880	737,274	280,549		1,017,823
1980	156.1	52.0		208.1	226,033	86,622		312,655	784,515	298,335		1,082,850
1985	165.2	55.1		220.3	239,210	91,786		330,996	830,250	316,120		1,146,370
Model II: quarters, 45%; manufacturing, 50%; canned, 5%												
1975	88.0	97.8	9.8	195.6	127,424	162,915	22,414	312,753	442,263	561,096	84,949	1,088,308
1980	93.6	104.0	10.5	208.1	135,533	173,243	24,015	332,791	470,408	596,666	91,017	1,158,091
1985	99.1	110.1	11.0	220.3	143,497	183,405	25,158	352,060	498,049	631,665	95,349	1,225,063
Model III: quarters, 25%; manufacturing, 35%; canned, 40%[d]												
1975	48.9	68.5	78.2	195.6	70,807	114,107	130,266	315,318	245,757	392,996	493,708	1,132,461
1980	52.0	72.9	83.2	208.1	75,296	121,437	138,595	335,328	261,337	418,241	525,275	1,204,853
1985	55.1	77.1	88.1	220.3	79,785	128,433	146,757	354,975	276,918	442,336	556,209	1,275,463

[a] Simpson (1974).
[b] The conversion coefficients for carcass weight to product weight are: quarters, 1.00; manufacturing, 0.7162; canned, 0.6543. Final demand values are calculated by multiplying projected exports times the international price as of August 1973 for the major item, extract, and high priced cuts. The prices are: quarters, $1,448.00; manufacturing, $1,665.80; and canned, $2,287.10.
[c] The type II multipliers are: quarters, 3.4708; manufacturing, 3.4441; and canned, 3.7900. See table 2.
[d] Percentages on carcass weight basis.

75% of exports, frozen boneless manufacturing and special cuts 25%, and canned beef 0%.[12] If prices were at 1973 levels, there would be about $312 million in foreign exchange earnings and approximately $108 billion in direct and indirect multiplier effects by 1980. The government's plan to concentrate exports on beef cuts rather than quarters or sides is given in model II. As can be appreciated, the additional processing would considerably increase both final demand payments and direct and indirect effects. An alternative in which canned beef plays an important role (40% of exports) is presented in model III.

The direct and indirect benefits from model III over the current product mix are apparent as $1.20 billion of economic activity would be generated by 1980 after adopting canned beef versus $1.08 billion from the current mix, assuming August 1973 prices. This is $47 million more than the government's target plan (model II) and $122 million more than the present situation.[13] In percentage terms, this is 11% more than under the present product mix and five % more than the government plan. If the projections included cooked/frozen beef as one export product, the total direct and indirect activity would be even greater.[14]

New machinery must be imported to allow a canned beef or cooked/frozen beef industry to develop. The foreign exchange earnings are given below the columns headed "estimated final demand." Under the government plan, about $333 million of foreign exchange earnings per year would be garnered by 1980 (table 3).[15] If the alternative with canned beef is

[12] The multiplier for the myriad of wholesale cuts from steers was determined to be about the same as the one for manufacturing beef. Thus, the entire group of wholesale cuts is lumped under the item manufacturing beef.

[13] The Government of Uruguay has set targets in which quarters represent 45% of exports, manufacturing 50%, and canned beef 5%. With this product mix, $1.15 billion of economic activity would be generated in the economy by 1980 given the earlier assumptions on price and quantity. This is an improvement of $70 million over the contemporary export makeup. See model II in table 3.

[14] The absolute size of the numbers will change due to price differences, supply availabilities, export taxes, and structural changes which would affect multiplier size. Nevertheless, the relative differences can be expected to remain about the same. Projections of income follow the same pattern as output.

[15] Both production and consumption of beef in Uruguay are extremely variable so that the absolute size of the imports must be interpreted with care. Furthermore, while some of the examples are for 1975, this is for expository purposes only as it is recognized

adopted, \$335 million annually of foreign exchange would be earned or \$2 million per year more.[16] The additional foreign exchange earnings would cover the exchange lost due to the imported capital improvements in a few years.

Clearly, it must be cautioned that all beef-exporting countries in Latin America cannot expect to develop an export market based on canned beef or cooked/frozen beef as the limits to growth are bounded by market demand. Nevertheless, fiscal policies and trade restrictions can be placed on the export of manufacturing beef which is used to a great extent by the importing countries to produce products which compete with cooked/frozen beef and canned beef. This would have the effect of increasing the size of the market for the cooked/frozen and canned beef.

Conclusions and Discussion

A method for disaggregating I-O studies into product lines was presented. Following a discussion of the new methodology, output and income multipliers for four South American beef exports were given and policy implications for one study country (Uruguay) presented in detail. The results from expanding the meat-processing sector along historic product lines demonstrates how radically the total economic activity in a country is changed by exporting different product mixes.

The analysis indicates that canned and cooked/frozen beef, while generally considered low quality or inferior products, are (in terms of direct and indirect impacts on the economy) actually "high quality" products.[17] Uruguay could, for example, increase its total direct and indirect economic effects by more than 11% if canned beef exports grew from less than 1% to 40% of export product mix.

One ramification of the study is recognition of the need for further research on the possibility of preparing and inserting budgets from industry-wide feasibility studies for one country in the I-O study for another country to obtain comparative multipliers. Naturally, considerable judgment would be necessary in selecting a country with similar conditions, but the five I-O analyses in which data for cow beef exports were studied show that the multipliers were fairly stable between countries. Clearly, more research is needed testing this method in other industries to determine problems not uncovered in this study before definitive recommendations can be made.

The study results to date demonstrate that, if product lines are not delineated, differences between product lines are never appreciated. Considering the importance of stimulating economic activity in the less developed countries, the differences in direct and indirect economic effects should receive major consideration.

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that the industry cannot shift over to producing canned beef or cooked/frozen beef by that time.

[16] In ten years, for example, about \$20 million of additional revenue would be obtained. It is estimated that \$3–\$6 million worth of additional imported machinery would be required to meet the output requirements of model III. A \$2 million per year differential by 1980 is fairly large for a country in which nearly all foreign exchange is earned by beef exports. Whether canned beef is added or not, table 3 shows that final demand could be increased by about \$20 million per year by 1980 by just implementing the government plan.

[17] The multiplier from cooked/frozen beef and canned beef is sufficiently high that Latin American nations may find it advisable to promote the development of the canned and cooked/frozen beef industries but with one modification—diversification into canned product lines other than corned beef. Some examples are beef stew with vegetables, canned Mexican food, corned beef hash, and Italian food such as spaghetti.

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Prices and Incomes in Linear Programming Models

John H. Duloy and Roger D. Norton

A procedure is developed for representing competitive and noncompetitive market structures in linear programming models. Arbitrarily close approximations to nonlinear forms—in both the objective function and constraint set—can be made without much loss of the computational efficiency of the simplex algorithm. The noncompetitive market structure may be used for measuring income at endogenous prices in a competitive model and may serve as a constraint on that measure of income to represent certain classes of economic policies. Product substitution effects in demand can be approximated by a linear program. The demand structure can be transformed to take account of any shift in demand which can be represented by a rotation of the demand function.

Key words: market structures, linear programming, substitution in demand.

The use of mathematical programming to simulate market behavior has been explored extensively in a number of studies since Samuelson first pointed out in 1952 that an objective function exists whose maximization guarantees fulfillment of the conditions of a competitive market. While some of the studies have been purely theoretical, his basic idea also has proven fruitful in the realm of empirical economics, particularly in the context of agricultural planning models which may contain rather detailed supply side specifications.

Nevertheless, in practice the existing empirical formulations of the idea are incomplete and awkward to use in a number of respects. This paper attempts to close some conceptual gaps and to make the idea more usable. Since the simplex algorithm is the most powerful computational programming algorithm available, linear programming (LP) is adopted as the context for the analysis. However, techniques are adapted by which some classes of nonlinear programming problems can be approximated almost arbitrarily closely at very little increase in computational difficulty.

The procedures described in this paper have been applied in policy analyses for Mexican agriculture (Bassoco and Norton, Duloy and Norton 1973b) and they have been extended in theory to the case of stochastic production levels (Hazell and Scandizzo), but a rigorous exposition of the approach has not been widely available heretofore.

Antecedents

Starting with Samuelson and Enke, a number of authors contributed over a span of twenty years to the conceptualization of static, single-product market demand structures with prices and quantities endogenous, in the context of mathematical programming models. Iterative LP procedures were proposed in Fox, Judge and Wallace, Schrader and King, King and Schrader, Tramel and Seale, and Yaron, but no progress had been made on efficient, noniterative solution procedures. Interdependence in demand had not been formulated in terms suitable for LP, nor had attention been paid to the problem of defining a variable, in either linear or nonlinear models, which represents producers' income as evaluated at the model's current endogenous prices. *Ex post* calculations can always be made, but if income levels are to be constrained in the solution they must be defined as variables at endogenous prices. This question has considerable empirical importance since many agricultural program parameters

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are set according to target levels of producers' income.

Takayama and Judge (1964a, 1964b, 1971) established complete formulations for the case of quadratic programming, but as an algorithm it is not nearly as powerful as the simplex method. Consequently, it does not permit incorporation of the degree of detail regarding factor supplies and product demands which is usually necessary in an applied policy planning model.[1]

Without taking into account interdependence in demand, Martin spelled out in detail the piece-wise linear specification of product demand and factor supply functions in an LP model of competitive markets. He obtained, for the first time, equilibrium LP solutions without iterations. But regarding income at endogenous prices, he did not go beyond suggesting *ex post* evaluation and, if income is a relevant variable, an iterative sequence of solutions. Also, his stepped approximation technique is more costly computationally than the one described later in this paper. In this entire series of reports in the literature, one of the most significant empirical uses of LP (with separable, piece-wise linear demands) was that of Farhi and Vercueil for the French national agricultural planning model.

Given this background, this paper provides four additions to the earlier contributions, all in the context of LP: (*a*) a workable method of handling interdependence among products in demand, (*b*) a method for defining a producers' income variable at endogenous prices, without resort to iterations, (*c*) a simple method for adjusting the LP coefficients of the demand system to reflect changes in population and per capita income, which permits comparative statics analysis, and (*d*) an application of grid linearization techniques (Miller, Hadley) to permit arbitrarily close approximation to nonlinear demand functions without increasing the number of rows in the model. By this last technique, nonlinearities in both the constraint set and the objective function can be handled with LP algorithms. All of these elements may be viewed as steps toward making the Samuelson market determination idea usable in the context of large-scale optimization planning models. In the CHAC model for Mexico, there were thirty-three agricultural commodities, including several in the oilseeds and forage groups.[2] Consequently, it was necessary to develop some expression of interdependence in demand, and the number of crops ruled out an iterative equilibrium-seeking procedure. The sheer size of the model, combined with the need to make many solutions to explore alternative hypothetical policy packages made mandatory the use of the simplex algorithm instead of a nonlinear algorithm. For a full description of CHAC, including a brief outline of the demand structures presented here, see Duloy and Norton (1973a).

Motivation: Uses in Planning Models

This stream of the literature has had little impact on the analytic side of the national planning tradition. In the classic LP models of an economy or subeconomy, either infinitely elastic demand functions are assumed or an upper bound on the quantities to be traded is specified. Modifications sometimes are made for exports which constitute a significant share of the world market, leading to a formulation in which the optimizing unit equates marginal revenue and marginal cost on the export markets, but normally the existence of international markets is used to justify the price-taker assumption. However, for a large class of products, particularly agricultural commodities, the spread between CIF and FOB prices may be 20% or more, and for another group of products trading opportunities effectively do not exist. In these cases, domestic product demand functions are relevant in price determination.

Incorporating product demand functions into a planning model designed for the purpose of analyzing policy alternatives, rather than assuming exogenously determined product prices, has three principal advantages. First, it allows the model to correspond to a market equilibrium. The effects of various policies, e.g., subsidizing or taxing product input prices or varying the exchange rate, can then be investigated. Second, it allows the model greater flexibility. For instance, substitution between capital and labor, corresponding to different factor price ratios, can occur not only directly through the technology set or through changes in the commodity mix of trade, but also through substitution in demand due to

[1] The relative ease of handling large-scale models by means of LP is especially relevant to the construction of sector-wide planning models, where incorporation of considerable detail by location and product is almost unavoidable in order to assure useful results.

[2] The word CHAC is the Mayan name for a rain god.

changing relative prices of products which are more or less labor-or capital-intensive. Third, it permits an appraisal of the distribution between consumers and producers of benefits accruing from changes in output. For example, in the common situation of agricultural production for the domestic market in the face of demand curves with elasticities which are less than unity in absolute value, the returns from increased output are negative to producers as a whole and positive to consumers.[3] Given these considerations, this paper attempts to facilitate wider use of market equilibria specifications in planning models.[4]

The Basic Model

Throughout, the exposition is developed in terms of a static LP model. Experience with these models amply indicates that the linearity does not prevent incorporation of significantly nonlinear behavior in the model.

The specification of the objective function follows from the choice of market form to be incorporated in the model. In the competitive case, producers act as price takers and equate marginal costs to the prices of products. In the monopolistic case, the sector maximizes its net income by equating marginal costs to the marginal revenues of products. For simplicity of exposition, the introduction of international trade is deferred to a later section.

In general terms, the static demand function may be written in inverted form as

$$(1) \qquad p = \phi(q, Y),$$

where p is an $N \times 1$ vector of prices, q is an $N \times 1$ vector of quantities, and Y is an exogenous scalar representing (lagged) permanent income.

For an unconstrained model, the objective function for the competitive case may be written as

$$(2) \qquad Z = \int_0^{q_n} \cdots \int_0^{q_1} \phi(q, Y) dq - c(q) \rightarrow \max_q,$$

where $c(q)$ is an $N \times 1$ vector of total cost functions and $q \geq 0$. In this case, setting the derivative of equation (2) with respect to q equal to zero yields

$$(3) \qquad p - c'(q) = 0,$$

which is the equilibrium condition of price equals marginal cost.

The LP Formulation

To present an example of a LP formulation, the case of linear demand functions is used, although the procedure in general places no restriction on the shape of the demand function except that the Hessian matrix of detached coefficients of the joint demand functions be negative semidefinite in order to insure convexity of the program. The variable Y is dropped from the demand function since the model is static. Equation (1) may be rewritten as

$$(4) \qquad p = a + Bq,$$

where a is an $N \times 1$ vector of constants, and B is an $N \times N$ negative semidefinite matrix of demand coefficients.

The objective function, equation (2), then becomes

$$(5) \qquad Z = q'(a + 0.5Bq) - c(q) \rightarrow \max_q.$$

The objective function can be decomposed into components[5] which correspond to consumer surplus (CS) and producer surplus (PS):[6]

$$(6) \quad CS = 0.5q'(a - p) = 0.5q'Bq,$$
$$(7) \quad PS = q'p - c(q) = q'(a + Bq) - c(q).$$

In addition to the explicit costs, $c(q)$, there usually are resources whose availability is constrained, so the model is extended by adding the conditions:

$$(8) \qquad Aq \leq b,$$

[3] None of these advantages accrue when a model is designed with fixed production targets and marginal supply prices for products are derived from the dual solution.

[4] The paper by Evans deals with a general equilibrium optimizing model with demand functions and endogenous prices at the economy-wide level but, for lack of a LP market structure specification, he falls back on the inefficient procedure of iterations of LP solutions.

[5] This objective function is essentially identical to Samuelson's "net social payoff" function, except that he includes interregional transportation costs whereas here only a single point in space is treated. The same objective function is elaborated in the multiproduct case by Takayama and Judge (1964b).

[6] Of course, the equation (2) may be interpreted merely as an equilibrium-seeking device, thus sidestepping the controversies surrounding the Marshallian surpluses. (See, for example, Mishan). An alternative interpretation of the objective function is possible; it can be interpreted as the profit function of a discriminating monopolist. Such an interpretation, of course, is hardly tenable for a sector-planning model, partly on account of problems of separability of markets but also because of the fact that the demand functions would require some reformulation on account of income effects.

where A is an $M \times N$ constraint matrix and b is an $M \times 1$ vector of resource availability levels.

For this constrained maximization problem, the Kuhn-Tucker necessary conditions are equation (8) plus

$$(9) \qquad p - c'(q) - \lambda A \leq 0,$$
$$(10) \qquad [p - c'(q) - \lambda A]q = 0,$$

and

$$(11) \qquad \lambda[Aq - b] = 0,$$

where λ is the vector of dual variables to the LP.

Equation (9) says that profits must be nonpositive. Profits per unit are defined as prices minus marginal costs, where costs now have two components, the explicit (market) costs of inputs whose behavior is subsumed in the vector of cost functions $c(q)$ and the economic rents which accrue to the use of the fixed factors represented by the vector b. Equation (10) is the complementary slackness condition which says that for every activity of nonzero level in the optimal basis, profits are zero and that for an activity with nonzero profits at given levels of use, it cannot enter the optimal basis at any of those levels. Equation (11) is the complementary slackness condition for the dual solution; either a resource's rent is nonzero or its slack is nonzero, but not both.

Taken together with Euler's theorem, which guarantees equality in equation (9) for activities which enter positively in the optimal basis, these conditions describe the characteristics of a system of competitive markets when fixed factors are used in the productive process. As such, they constitute a generalization of equation (3) which is particularly relevant to agriculture.

To describe the monopolistic equilibrium with the LP model, the appropriate objective function would be

$$(12) \qquad M = q'(a + Bq) - c(q) \to \max_{q}.$$

The Kuhn-Tucker conditions for this version of the model are equation (8) and

$$(13) \qquad a + 2Bq - c'(q) - \lambda A \leq 0,$$
$$(14) \qquad [a + 2Bq - c'(q) - \lambda A]q = 0,$$

and

$$(15) \qquad \lambda[Aq - b] = 0.$$

The only difference between equations (9)–(11) and equations (13)–(15) is that the vector p is replaced by the term $a + 2Bq$, which is the vector of marginal revenues. Therefore the previous interpretations of equations (9)–(11) are maintained subject to substitution of "marginal revenue" for "price." Hence, the model given by equations (12) and (8) guarantees the monopolistic equilibrium as the optimal solution.

Under the linear demand function, the competitive maximand, equation (5), and the monopolist's maximand, equation (12), both involve a quadratic form in p. With nonlinear demand functions, the maximands are polynomials of a higher order. Two linear approximation procedures have been developed; the first is the case where estimates of the coefficients of B are available (interdependence among products in demand) and the second where less information is known about the structure of demand (separability assumed). In this section the latter case is examined.

In order to set up the LP tableau, a function representing the area under the demand curve is defined as

$$(16) \qquad W = q'(a + 0.5Bq),$$

and also a total expenditure (= gross revenue) function is written as

$$(17) \qquad R = q'(a + Bq).$$

The demand function, equation (4), and the counterparts, equations (16) and (17), are shown diagramatically in figure 1.

Note that for a linear demand function, both W and R are nonlinear. The approximation procedure, however, involves direct segmentation of W and R instead of the demand function. Since W is the positive component of the maximand, any point below W (fig. 1) is inefficient and hence nonoptimal. In the piecewise linear approximation to W, optimality guarantees that no more than two nodes (two points on the q axis) will enter the optimal basis. The representation of the piece-wise linear approximation in LP is shown for the two-good case, with additive separability in demands, in table 1, where it is assumed that the model may include a constraint value, $Y^* \geq 0$, on producers' income.[7]

Note that in table 1, no more than two adjacent activities from the set of selling activities (each corresponding to one segment in the approximation) will enter the optimal basis at

[7] This is an application of the grid-linearization technique of separable programming as proposed by Miller.

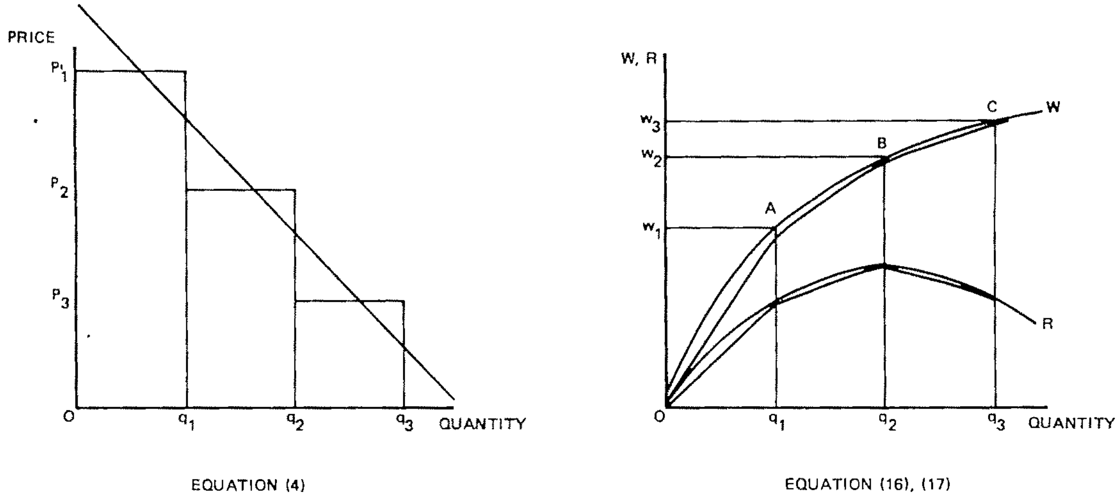

Figure 1. Demand and expenditure equations

positive levels. As argued above with reference to the W function in figure 1, a linear combination of more than two points is a line interior to the piece-wise efficiency frontier $OABA$. The principal advantage of this formulation over a more straightforward segmentation is that the demand function (or area function W) can be approximated as closely as desired without requiring additional constraints in the program. The number of selling activities increases as the number of linear segments increases, but the number of rows remains constant. And, by use of the function R in the constraint set, the model includes a measure of income at endogenous prices.

In table 1, for illustration only, the demand functions for the two commodities are segmented into two and three steps, but in the operational versions of the Mexican model CHAC, up to thirty-five segments per commodity were used.

Substitution in Demand

In the event that two or more products are not separable in demand, the nonlinear demand set can be linearized directly, to an arbitrarily close approximation, by specification of activity vectors representing points on the demand surface and by incorporating an appropriate convex combination constraint. An example of the tableau in such a case, for two products and six segments per term in the objective function, is shown in table 2.

In the treatment of this second tableau, it is assumed that the elements of the matrix B, including off-diagonal elements, in equation (4) are known or can be estimated. Frequently, the available information consists only of estimates of own-price elasticities for a number of individual commodities and commodity groups, so an alternative approach is required.

Table 1. LP Tableau with Separable Demands

	Production Activities		Selling Activities					RHS
	Good 1	Good 2						
Objective function	$-c_{1j}$	$-c_{2j}$	w_{11}	w_{12}	w_{21}	w_{22}	w_{23}	(max)
Income constraint	$-c_{1j}$	$-c_{2j}$	r_{11}	r_{12}	r_{21}	r_{22}	r_{23}	$\geq Y^*$
Commodity balance 1	y_{1j}		$-q_{11}$	$-q_{12}$				≥ 0
Commodity balance 2		y_{2j}			$-q_{21}$	$-q_{22}$	$-q_{23}$	≥ 0
Demand constraint 1			1	1				≤ 1
Demand constraint 2					1	1	1	≤ 1

Note: Costs for the ith product in the jth activity producing it are represented by c_{ij}; unit outputs of the ith product in the jth activity producing it are given by y_{ij}. The quantities sold of the ith product corresponding to the endpoint of the jth segment are defined as q_{ij}. Values of W for the ith commodity corresponding to the amount sold, q_{ij}, are given by w_{ij}. Values of R for the ith commodity corresponding to the amount sold, q_{ij}, are represented by r_{ij}. The target level of producer's income is denoted by Y^*. It is set equal to zero (or at any nonnegative value such that the constraint is nonbinding) for the competitive case. It becomes the objective function in the monopolistic case.

Table 2. LP Tableau with Substitution in Demand, Two Products

	Production Activities Good 1	Production Activities Good 2	Selling Activities						RHS
Objective function	$-c_{1j}$	$-c_{2j}$	w_{11}	w_{12}	w_{13}	w_{21}	w_{22}	w_{23}	(max)
Income constraint	$-c_{1j}$	$-c_{2j}$	r_{11}	r_{12}	r_{13}	r_{21}	r_{22}	r_{23}	$\geq Y^*$
Commodity balance 1	y_{1j}		$-q_{11}$	$-q_{11}$	$-q_{11}$	$-q_{12}$	$-q_{12}$	$-q_{12}$	≥ 0
Commodity balance 2		y_{2j}	$-q_{21}$	$-q_{22}$	$-q_{23}$	$-q_{21}$	$-q_{22}$	$-q_{23}$	≥ 0
Convex combination constraint			1	1	1	1	1	1	≤ 1

Note: The symbols are as defined in table 1.

The basis of the approximation procedure developed for this situation of limited information is the assumption that commodities can be classified into groups, such that the marginal rate of substitution (MRS) is zero between all groups but nonzero and constant within each group. Clearly this assumption is only an approximation to reality. A group may consist of one or more commodities, and limits are defined on the variability of the commodity mix within each group. The relevant portions of the indifference surface with respect to two commodities in a group are shown in figure 2. The rays OC and OD in the figure define the limits on the composition of the commodity bundle. If sufficient information is available, the approach can be extended to more linear segments per indifference curve, each segment representing a different value of the MRS.

Consider a group consisting of C commodities. The appropriate LP tableau may be represented in general form as in table 3. In table 3, each of the blocks of activities $[W'_s, R'_s - Q'_s, 1]$ constitutes a set of "mixing" activities for one segment of the composite demand function for the commodity group. This block of activities can be written as

$$(18)\quad \begin{bmatrix} W_s \\ R_s \\ -Q_s \\ 1 \end{bmatrix} = \begin{bmatrix} w_s & w_s & \cdots & w_s & \cdots & w_S \\ r_s & r_s & \cdots & r_s & \cdots & r_S \\ -q_{s11} & -q_{s12} & \cdots & -q_{s1m} & \cdots & -q_{S1M} \\ -q_{s21} & -q_{s22} & \cdots & -q_{s2m} & \cdots & -q_{S2M} \\ -q_{sc1} & -q_{sc2} & \cdots & -q_{scm} & \cdots & -q_{ScM} \\ \vdots & \vdots & & \vdots & & \vdots \\ -q_{sC1} & -q_{sC2} & \cdots & -q_{sCm} & \cdots & -q_{SCM} \\ 1 & 1 & \cdots & 1 & \cdots & 1 \end{bmatrix},$$

where the elements are as defined below and the 1 represents the unit vector.

The derivation of formulae for the elements

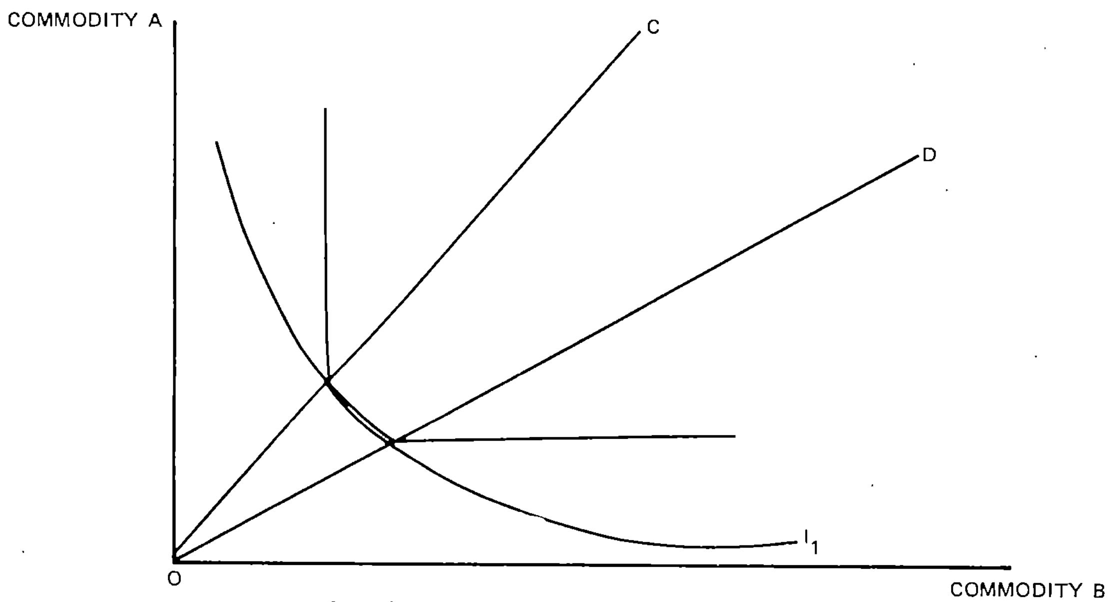

Figure 2. Indifference surface depicting limited commodity substitution

Table 3. General LP Tableau with Substitution in Demand

	Production Activities	Selling Activities						RHS
Objective function	$-C$	W_1	...	W_s	...	W_S	...	(max)
Income constraint	$-C$	R_1	...	R_s	...	R_S	...	$\geq Y^*$
Commodity balance	X	$-Q_1$	...	$-Q_s$	...	$-Q_S$	...	≥ 0
Convex combination constraint		1	...	1	...	1	...	≤ 1

Note: The segment index is $s = 1, 2, \ldots, S$. The row vector of production costs is C. A C-rowed matrix of production coefficients entering the commodity balances is given by X. Vectors $(1 \times C)$ of areas under the demand functions and gross revenue functions, respectively, are given by W_s and R_s. A $C \times C$ matrix of adjusted quantities, as defined below, is Q_s, and 1 is the unit row vector on the left-hand side of the equation.

of equation (18) is tedious because they take account of shifts both between and among segments. The starting point is a set of observed prices $\{p_1^o, \ldots, p_c^o, \ldots, p_C^o\}$ and a set of quantities $\{q_1^o, \ldots, q_c^o, \ldots, q_C^o\}$. Relative prices of commodities in the group are assumed fixed, both within and between segments, and are defined by

$$\rho_c = p_c^o/\sum_c p_c^o. \tag{19}$$

Corresponding to the observed sets of prices and quantities are a quantity index,

$$q^o = \sum_c q_c^o \rho_c^o, \tag{20}$$

and a price index,

$$p^o = \sum_c p_c^o q_c^o / V^o, \tag{21}$$

where

$$V^o = \sum_c q_c^o. \tag{22}$$

It is assumed that an estimate of a demand function exists for the group with a price index as a function of a quantity index, as in equations (20) and (21). Assume for a moment that no substitution occurs among commodities (i.e., that they are consumed in the fixed observed proportions), and that the demand function is segmented in S segments. Then this case corresponds to the tableau in table 4, which is a simple extension of the single product case. Only the selling activities are shown.

In table 4, it is evident that

$$q_{sc} = a_c^o V_s, \tag{23}$$

where $a_c = q_c^o/V_s$, the observed proportion in physical units of the cth commodity, and V_s is the total quantity sold in the sth segment, in physical units; W_s and R_s are, of course, computed from the demand function with appropriate price and quantity indexes although, in table 4, the weights are all constant. The price-weighted total quantity is

$$q_s^{o*} = \sum_c \rho_c q_{sc} = V_s \sum a_c^o \rho_c. \tag{24}$$

To extend the case of demand in fixed proportions within a group, it is supposed that for C commodities, the set of feasible alternative mixes as proportions in physical terms is given by the matrix A, assumed for simplicity to be invariant across segments:

$$A = [a_{cm}], \tag{25}$$

where $c = 1, \ldots, C$ commodities in the group; $m = 1, \ldots, M$ mixes of the commodities; and a_{cm} = the proportion in physical terms of the cth commodity in the mth mix, such that $\sum_c a_{cm} = 1$. The elements, a_{cm}, define the rays shown in figure 2.

The elements in matrix Q_s in equation set (18) can now be defined as

$$q_{scm} = a_{cm} V_s \sum_c a_c^o \rho_c / \sum_c a_{cm} \rho_c, \tag{26}$$

Table 4. LP Tableau with C Commodities in Alternative Fixed Proportions

	Selling Activities					
Objective function	W_1	...	W_s	...	W_S	(max)
Income constraint	R_1	...	R_s	...	R_S	$\geq Y^*$
Commodity balances	$-q_{11}$	...	$-q_{s1}$	...	$-q_{S1}$	≥ 0
	$-q_{12}$	...	$-q_{s2}$	...	$-q_{S2}$	≥ 0
	.		.		.	.
	.		.		.	.
	.		.		.	.
	$-q_{1C}$	...	$-q_{sC}$	...	$-q_{SC}$	≥ 0
Convex combination constraint	1	...	1	...	1	≤ 1

which differs from the expression for q_{sc} (consumption in fixed proportions) in equation (23) by the factor $\sum_c a_c{}^o\rho_c/\sum_c a_{cm}\rho_c$, which reflects the changing commodity weights. Using equation (24), equation (26) can be rewritten as

$$(27) \qquad q_{scm} = a_{cm}q_s{}^{o*}/\sum_c a_{cm}\rho_c.$$

The price-weighted total quantity, $q^*{}_{sm}$, is given by

$$(28) \qquad q^*{}_{sm} = \sum_c \rho_c q_{scm} = q_s{}^{o*},$$

that is, the price-weighted quantity of the aggregate commodity is independent of the commodity mix, and it can be written as $q^*{}_s$. Using this result, equation (26) can be simplified as follows:

$$(29) \qquad q_{scm} = a_{cm}q^*{}_s/\sum_c a_{cm}\rho_c.$$

This completes the definition of the elements of the matrix Q_s in equation set (18). By equation (28), $q^*{}_s$ is invariant with respect to the commodity mix, so that the elements of w_s and r_s are invariant over the mixing activities. They are computed exactly as in the single product case, using $q^*{}_s$ in place of q_s. To recapitulate, if the demand function is linear,

$$(30) \qquad w_s = q^*{}_s(a - \frac{1}{2}bq^*{}_s),$$

and

$$(31) \qquad r_s = q^*{}_s(a - bq^*{}_s).$$

The demand side of a model may be constructed to incorporate a number of product groups, some of which can consist of a single commodity. Between product groups, the MRS is zero, and within, it is constant and given by the inverse of the price ratio. It is this last property which leads to the constancy of consumer surplus $(w_s - r_s)$ and of consumer expenditure (r_s) within a commodity group.

The constancy of the MRS can readily be shown for the case of two products (table 5), where again only the selling activities are included.

By the constancy of w_s and r_s, movement along a given indifference function requires changes in the activity levels, x_1 and x_2, which are equal but of opposite sign. Without loss of generality, consider the two cases $(x_1 = 1, x_2 = 0)$ and $(x_1 = 0, x_2 = 1)$. Then the MRS is given by equations (32), dropping the subscript s and the parameter $q^*{}_s$, which are common to all terms:

Table 5. LP Tableau for Limited Substitution with Two Commodities in a Segment

Activity level	x_1	x_2	
Objective function	w_s	w_s	(max)
Income constraint	r_s	r_s	≥ 0
Commodity balances	$-q_{s11}$	$-q_{s12}$	≥ 0
	$-q_{s21}$	$-q_{s12}$	≥ 0
Convex combination constraint	1	1	≤ 1

$$(32) \qquad MRS = \frac{\Delta_1}{\Delta_2} = \frac{q_{11} - q_{12}}{q_{21} - q_{22}} = \frac{a_{11}/\sum_c a_{c1}\rho_c - a_{12}/\sum a_{c2}\rho_c}{a_{21}/\sum_c a_{c1}\rho_c - a_{22}/\sum a_{c2}\rho_c}.$$

By expanding and rearranging equation (32),

$$(33) \qquad \frac{\Delta_1}{\Delta_2} = \frac{-\rho_2}{\rho_1},$$

which is the required result.

Comparative Statics and International Trade

This specification of commodity demand structures incorporates one characteristic which makes it particularly convenient for obtaining comparative statics solutions. The demand function for any commodity group can be rotated merely by an appropriate change in the constraint value of the convex combination inequality, i.e., the matrices W_s, R_s, Q_s are invariant under this class of transformations of the commodity demand function.

The transformation of the demand function for a single product is illustrated in figure 3, assuming that the function in linear. The original demand function and corresponding W function are shown as D_1D_1 and OW_1, respectively, in figure 3, and the rotated demand function and corresponding W function are shown as D_1D_2 and OW_2, respectively. If the original demand function is

$$(34) \qquad p = f(q),$$

it is required that the transformed function can be expressed as

$$(35) \qquad p = f(kq).$$

Such a formulation readily accommodates shifts in the demand function due to changes in population and/or per capita incomes. The rotation upwards of the demand function is

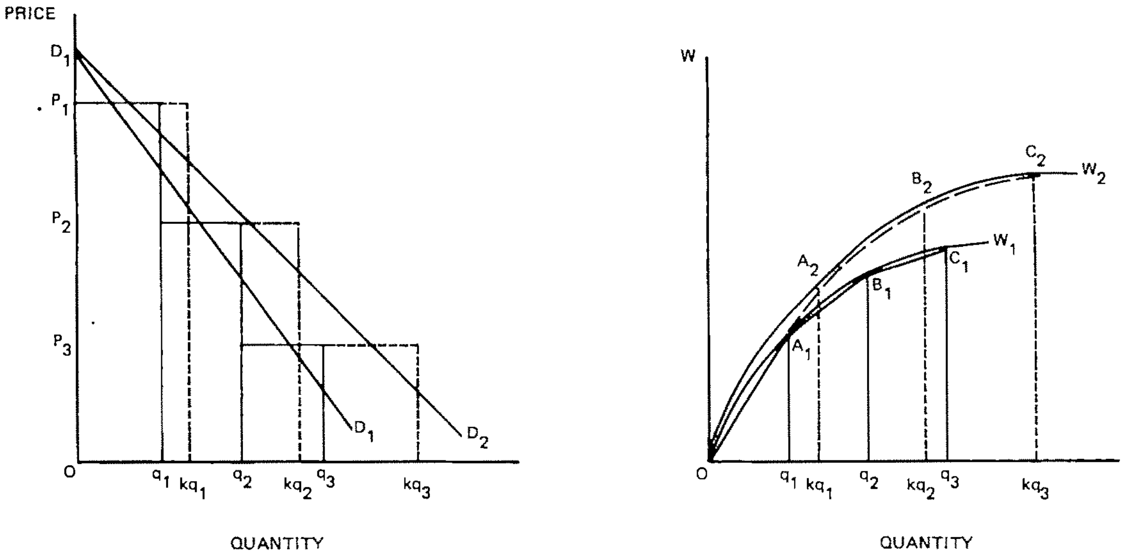

Figure 3. Transformation of a demand function

expressed as a proportional lengthening of the segments with price held constant. For the segmented W function, the slope of the linearized function in each segment, being the approximation to price within that segment, is equal for both W_1 and W_2 for corresponding segments. A similar condition holds for the linearized R function where the slopes are approximations to marginal revenue within the segment. Given linearity and the constancy of the slopes of the segmented functions within each segment, the coefficients in the W_s and R_s matrices can be expressed as simple multiples of the corresponding quantities. This is done for the transformed demand function in table 6, where again only the selling activities appear.

Simply by dividing all the elements of each activity by k and multiplying through the convex combination constraint by k, the program with the transformed demand function in table 6 can be seen to reduce to a program with coefficients in the constraint matrix identical to those before the demand transformation, but with k replacing unity on the right-hand side of the convex combination constraint. This result is readily extended to the commodity group case by replacing q_s with q^*_s and, in the objective function and income constraint, by replacing w'_s and r'_s by the corresponding vectors W'_s and R'_s, and by recalling that the matrices Q_s in the commodity balances can be written as scalar multiples of q^*_s.[8] This characteristic of the demand structure permits computationally simple parametric variation of the position of the demand function. It also opens the possibility in a larger system of endogenously determining both the position of the demand functions and the position on it.

A representation of international trade can readily be incorporated into the structures developed in this article in the usual way in which it is incorporated into planning models, that is, by adding commodity-specific importing activities as additional "production" activities and similarly by adding exporting activities as additional selling activities. Again, it is possible to specify import supply (export demand) as being infinitely elastic, but bounded, or as being represented by an up-

[8] Notice that q^*_s, being invariant over mixing activities, is a scalar.

Table 6. LP Tableau with a Transformed Demand Function

Objective function	$kq_1q'_1$	. . .	$kq_sw'_s$	. . .	$kq_Sw'_S$	(max)
Income constraint	$kq_1r'_1$	. . .	$kq_sr'_s$	. . .	$kq_Sr'_S$	$\geq Y^*$
Commodity balance	$-kq_1$	. . .	$-kq_s$	. . .	$-kq_S$	≥ 0
Convex combination constraint	1	. . .	1	. . .	1	≤ 1

Note: w'_s and r'_s are simply w_s and r_s divided by q_s, and k is the factor of proportionality by which the quantity demanded increases at a given price.

ward sloping supply (downward sloping demand) schedule. In this last case, it is possible to approximate the nonlinearities involved by the methods developed above. Notice, however, that it is only possible to specify a monopolistic formulation of export supply, or a monopsonistic formulation of import demand, if the objective function and the scope of the model represents multicountry welfare.

When trading opportunities are included as outlined above, the model captures the different trading positions posited by price theory and depending on relative domestic and foreign supply and demand functions and on whether the objective function is chosen to reflect competitive or monopolistic behavior. For example, in the monopolist case, final product importing activities never enter the optimal basis, and the model reproduces the expected two-price behavior when the foreign marginal revenue function lies above the domestic marginal revenue function.[9]

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[9] One case which the structure will not handle is the monopolist case where either of the demand functions is of the double-log form and where the elasticity of demand is less than unity in absolute value. In this case, marginal revenue is negative, but increasing, i.e., the function is nonconvex.

Efficiency Aspects of Profit-Sharing Systems versus Wage Systems

James R. Markusen

Some theoretical and practical bases for choosing between wage and profit-sharing reward structures are considered. The analysis suggests that simple wage systems have theoretical advantages over simple profit-sharing systems with regard to the optimal provision of labor effort. The opposite conclusion occurs with regard to the optimal use of capital. Furthermore, simple profit-sharing systems are better able to deal with certain practical problems that arise in large-scale agricultural production. Finally, a complex type of profit sharing exists which has the same theoretical advantages as the wage system plus practical advantages as well.

Key words: reward structure, Cournot behavior, cooperative behavior, distributive shares.

Over the past several decades economists have documented a growing diversification of goals and organizational forms in productive enterprise. Goals that might serve as alternatives to the traditional profit-maximizing objective include such things as worker welfare maximization, output (or revenue) maximization, and employment maximization. Output maximization as a firm goal has appeared in a number of different contexts, ranging from the new theories of managerial capitalism to discussions of state corporations and state farms in developing countries. Worker welfare maximization as a firm goal has been a building block of models of Soviet, Yugoslavian, and Chinese firms since the work of Ward (1958).

Discussions of organizational forms have usually appeared, interestingly, in the context of specific countries. Ward (1957, 1958, 1965) has analyzed the Yugoslav system, asking how such a firm will behave in comparison with its capitalistic counterpart. Domar has asked similar questions of the Soviet model. Works by Vanek (1965, 1970, 1972) present models that may be said to resemble the Chinese system while papers by Heady (1947, 1971) and Johnson basically discuss alternate organizational forms that are found in free enterprise systems, although Heady (1971) does treat state and collective farms. Kornai and Liptak present an analysis of the Hungarian system.

A very interesting problem that few of these authors address, however, is the question of what type of organizational structure a firm might choose if it had the ability to do so and how this choice might depend upon the particular goals of that firm. In the literature just cited, the authors tend to assume that firm goals and organizational structures are determined by the social and political forces exogenous to the firm rather than by the firm itself.

The purpose of this paper, then, is to evaluate two alternative reward structures around which individual firms could be organized. These reward structures are evaluated by their ability to achieve the profit, output, and worker welfare goals mentioned above. Other goals, such as the employment goal mentioned above, will not be discussed. The first type of organization assumes that management and labor are paid on a wage basis. The second type of organization assumes that the firm is organized on a pure profit-sharing basis. As the brief discussion of the literature given above may suggest, these two types of reward structures by no means cover the entire spectrum of organizational

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forms observed in the world today. It is not the purpose of this paper to provide a comprehensive discussion of organizational forms but rather to provide a relatively detailed and rigorous treatment of a narrow range of alternatives.

The wage system and the pure profit-sharing system will be evaluated from two points of view: First, are the organizational structures theoretically able to achieve the firm's goals? The methodology here involves the use of a formal model to derive the necessary conditions which must characterize the various maxima without introducing specific institutional arrangements about how remuneration is to be made. Inferences as to the optimality of each type of organization are then made by comparing the equilibrium conditions which characterize each type of organization to the optimality conditions derived earlier. If one type of organization will lead to optimal operation while a second type will not, then the former is, of course, theoretically superior to the latter. Second, the reward structures are evaluated relative to their ability to deal with certain practical problems which are not captured by the formal model. If one type of reward structure is better equipped to deal with these practical problems than the alternative method, the former is judged to be superior to the latter.

The theoretical approach adopted to a particular problem tends to depend fundamentally on the prejudices of the researcher and discussions of practical problems of organization must inevitably take place in a rather specific context. The theoretical methodology used here is decidedly neoclassical in flavor and focuses heavily on the issue of labor effort. This tends to reflect my own bias (though also a point of view prevalent in non-neoclassical literature) that one of the most important choice criteria for deciding between alternate organizational forms lies in the impact of the various structures on worker behavior. With regard to the practical problems associated with various organizational forms, it should be noted that the ideas contained in this paper were first developed while studying the organizational forms employed by a number of state agricultural projects in Ghana. As a complement to the theoretical analysis, therefore, the paper will relate the theoretical results to a number of problems which characterize large-scale agricultural production.

The results of the analysis suggest that simple wage systems have theoretical advantages over simple profit-sharing systems with regard to the optimal provision of labor services. The opposite conclusion occurs with regard to the optimal use of capital. It is also argued that simple profit-sharing systems are better equipped to deal with a number of practical problems. At a more complex level, it is shown that a profit-sharing system exists which has the same theoretical advantages as the wage system plus practical advantages as well. On the other hand, it is also shown that profit sharing cannot lead to output maximization unless there are subsidies to both the output price and the capital costs of the firm.

Profit, Welfare, and Output Maximization

We begin by assuming a firm which produces one output, denoted by Q, which it sells for a constant market price, p (demand is infinitely elastic). Two workers (any arbitrary number greater than one will do) produce Q with their own labor and a capital stock, denoted by K. The general quasi-concave continuous production function for the firm is denoted by

$$(1) \qquad Q = F(L^a, L^b, K),$$
$$F_i = \frac{\partial F}{\partial L^i}, \quad F_3 = \frac{\partial F}{\partial K},$$

where L^a and L^b denoted the labor inputs of workers A and B, respectively. This general formulation of the production function allows for differences in skill, effort, or roles (e.g., labor and management) between A and B. Finally, we will assume that labor is measured in some standard units of effort and not in hours.

The paper is initially limited to a short-run, static analysis in which capital is rented by the firm at fixed rates. The question of firm size under varying tenure forms and objective functions is also ignored since it was analyzed by Heady (1971). It is also assumed that the number of workers is fixed but that the effort of each laborer is a variable.[1] Unless other-

[1] This assumption of a fixed number of workers is consistent with the situation on Ghanaian State Farms. The farm manager is allowed a fixed number of workers, the number depending upon the acreage and the crops grown. The assumption that work time is fixed is also consistent with a number of situations. For example, working hours could be fixed, with L measured in units of "effort." If the work week is fixed at forty hours, the utility function then gives utility as a function of Q and L with forty hours of work as a parameter of the function. When the number of

wise indicated, the terms "laborer" and "worker" will refer to all employees of the firm, whether managers or common laborers.

It is assumed that workers possess utility functions with Y and L as arguments. These are written:

$$(2) \qquad U^i = U^i(L^i, Y^i)$$
$$U_1^i < 0 \qquad U_2^i > 0 \qquad i = a, b,$$

where U^i is assumed to be quasi-concave and where Y^i denotes the consumption (income) of the ith worker. For simplicity, it is assumed that the natural constraint on labor effort is nonbinding and hence omitted from the analysis.

Let r equal the constant rental rate of capital. Assuming that the firm neither borrows nor saves, revenues are divided among workers A and B, capital, and profit, denoted by Π:

$$(3) \qquad pQ = Y^a + Y^b + rK + \pi.$$

Now assume that the firm wishes to maximize profits subject to some minimum constraint on the welfare of the workers. The firm behaves as a strict profit maximizer when this welfare constraint is simply equal to the worker's opportunity cost. On the other hand, if we are describing an enterprise such as a state farm, the government planner may set the welfare constraint higher than the worker's opportunity cost. In either case, the general nonlinear programming problem can be written as follows:

$$(4) \quad \max\ pF(L^a, L^b, K) - Y^a - Y^b - rK,$$
$$\text{subject to} \quad U^i(L^i, Y^i) \geq \bar{U}^i, \quad i = a, b.$$

Other firms, such as partnerships, cooperatives, or worker-managed firms, as described in Ward (1958), may want to maximize worker welfare subject to some minimum profit constraint. Maximizing worker welfare must involve some welfare function which relates the individuals' welfare to a measure of total welfare. Denoting such a relationship as $W = W(U^a, U^b)$, the welfare maximization problem subject to a minimum profit constraint can be written as the following general nonlinear programming problem:

$$(5) \qquad \max\ W(U^a, U^b),$$
$$\text{subject to}$$
$$pF(L^a, L^b, K) - Y^a - Y^b - rK \geq \Pi.$$

workers is variable, the conclusions of Ward (1958), Vanek (1965), and Domar (1966) regarding the total employment in a profit-sharing firm are essentially applicable here.

Without introducing specific institutional arrangements for determining Y^a and Y^b, we can solve equations (4) and (5) for the necessary conditions which must characterize the optimums under all types of reward structures. For both equations (4) and (5), the first-order necessary conditions for an interior maximum[2] give

$$(6) \quad \frac{U_1^a}{U_2^a} = -pF_1, \quad \frac{U_1^b}{U_2^b} = -pF_2, \quad r = pF_3.$$

These conditions state that an interior optimum will be characterized by the fact that each worker's marginal rate of substitution between income and labor (this MRS is assumed to be negative) will equal the value of that worker's (negative) marginal product. The optimum requires a worker to increase his labor up to the point where his MRS equals the value of the marginal product of his last unit of labor. Beyond such a point, the marginal product of labor declines—by assumption in equation (1)—and the marginal disutility of labor in terms of income increases—by assumption in equation (2). The third equilibrium condition in equation (6) is the familiar value of marginal product condition. It states that capital should be hired up to the point where the value of its marginal product is just equal to the rental rate.

It is not surprising that these marginal rates of substitution conditions are the same for the two programming problems, equations (4) and (5). The firm must satisfy the same efficiency conditions whether it maximizes welfare subject to a minimum profit constraint or whether it maximizes profits subject to a minimum welfare constraint. This does not imply, however, that the solutions to the two problems will be identical.

One hypothetical situation is shown in figure 1. Assume that L^b and K are both fixed at some level and that they receive fixed payments of Y^b and rK, respectively. Let $G = pQ - Y^b - rK$; that is, G equals the total revenue product of L^a net of payments to L^b and K.[3] Note that G is simply a downward shift of pF and that the slope of G equals the slope of pF (the value of the marginal product of L^a) at all levels of L^a.

[2] The paper will assume interior solutions with all variables positive and inequality constraints holding with strict equality.

[3] We assume in this diagram and in the remainder of the paper that the marginal product of labor diminishes over the entire range of production. Such an assumption is unnecessary but helpful for exposition.

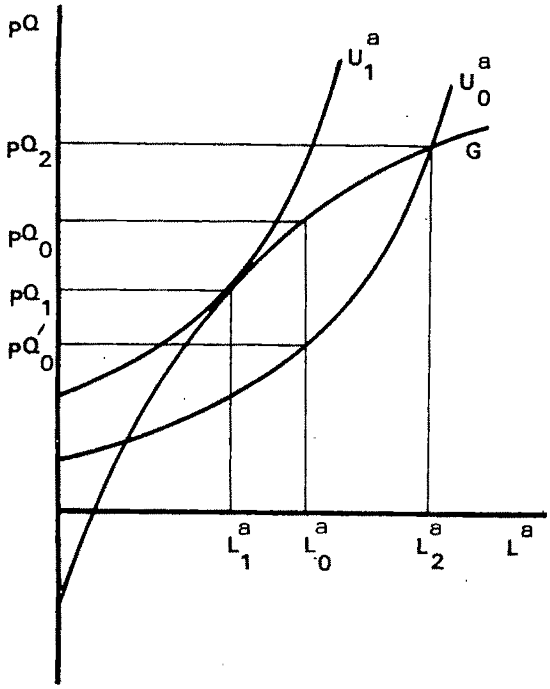

Figure 1. Profit, welfare, and output maxima

Worker A's opportunity cost welfare level is represented by U_0^a in figure 1, i.e., the level of welfare that he could achieve in this next best opportunity. The optimality conditions given in equation (6) state that profits are maximized where the worker's marginal rate of substitution is just equal to his (negative) marginal product. This occurs at L_0^a with G equal to pQ_0, the point at which the slopes of U_0^a and G are equal. Payments to worker A are equal to pQ'_0 and profits are equal to $p(Q_0 - Q'_0)$.

The welfare maximum for worker A occurs at L_1^a on indifference curve U_1^a (assuming profits are constrained by zero). The optimality conditions given in equation (6) imply that the slopes of U_1^a and G must be equal at this maximum. Note that we cannot in general tell whether output at the welfare maximum, Q_1, will be greater than or less than the output at the profit maximum, Q_0. The relationship between Q_1 and Q_0 depends upon the shape of the total product curve and the shape of the indifference map. Related ideas are expressed by Bronfenbrenner (1960), Quirk and Saposnik, Scitovsky, Ward (1958), and Vanek and Espinosa.

The two solutions will be identical if conditions are such that it is not possible to earn positive profits while paying opportunity cost wages. If U_1^a represents the opportunity cost of A in figure 1, both the profit maximizer and the welfare maximizer will produce at Q_1, L_1^a.

As a third alternative, the firm might want to maximize output subject to both profit and welfare constraints. Since maximizing output is the same as maximizing revenue when output price is fixed, output maximization is equivalent to solving the following programming problem:

$$\text{(7)} \qquad \max\ pF(L^a, L^b, K),$$

subject to

$$pF(L^a, L^b, K) - Y^a - Y^b - rK \geq \bar{\Pi}$$
$$U^i(L^i, Y^i) \geq \bar{U}^i, \quad i = a, b.$$

Again, without specifying actual institutional arrangements, the first-order necessary conditions for an interior optimum give us the following:

$$\text{(8)} \qquad \frac{U_1^a}{U_2^a} = -pF_1\left(\frac{1+\lambda}{\lambda}\right),$$

$$\frac{U_1^b}{U_2^b} = -pF_2\left(\frac{1+\lambda}{\lambda}\right), \qquad r = pF_3(1+\lambda),$$

where λ is the Lagrangean multiplier associated with the first constraint. Since $\lambda > 0$ when the profit constraint holds with equality, equation (8) implies that the output maximizing equilibrium will be characterized by the absolute value of the worker's MRS exceeding his value of marginal product. Similarily, capital will be hired past the point where the value of its marginal product equals the rental rate. In figure 1, the output maximizing equilibrium occurs at Q_2, L_2^a when profits are constrained by zero and worker A's welfare is constrained by his opportunity cost (U_0^a). At this equilibrium, the slope of U_0^a exceeds the slope of G. This will always be the case when it is possible to earn positive profits while paying opportunity cost wages.

On the other hand, if U_1^a represents worker A's opportunity cost welfare level, output maximization constrained by zero profit and opportunity cost welfare levels again occurs at Q_1, L_1^a where the slopes of U_1^a and G are equal (the value of λ approaches infinity). In this special case, the solution values to all three programming problems, subject to the constraint values as noted, are identical.

Wage Labor

Theoretically, it is always possible for the firm to design a wage system which will produce an optimum relative to any goal the firm may have. In fact, the mainstream of microeconomic literature generally assumes the optimality of wage systems and remains content with the derivation of the marginal conditions which a wage system should satisfy.

When a firm's labor force is fixed, however, and additional units of labor are supplied only at an increasing opportunity cost to the individual laborer, things become more difficult. Generally, it is not possible to achieve an optimum when workers are allowed to choose the quantity of labor they offer in exchange for a given wage rate. The firm must either give all-or-nothing offers (e.g., \$1 per hour for 40 "units of effort" take it or leave it) or offer a multiple wage package such as regular and overtime wages (e.g., \$1 per hour for 40 units plus \$1.50 per hour for all units over 40).

The situation is shown in figure 2. The total value product of A net of payments to B and capital is G; $G = pF - w\bar{L}^b - r\bar{K}$, the same as in figure 1. Worker A's opportunity cost welfare level is represented by $U_0{}^a$. Assume

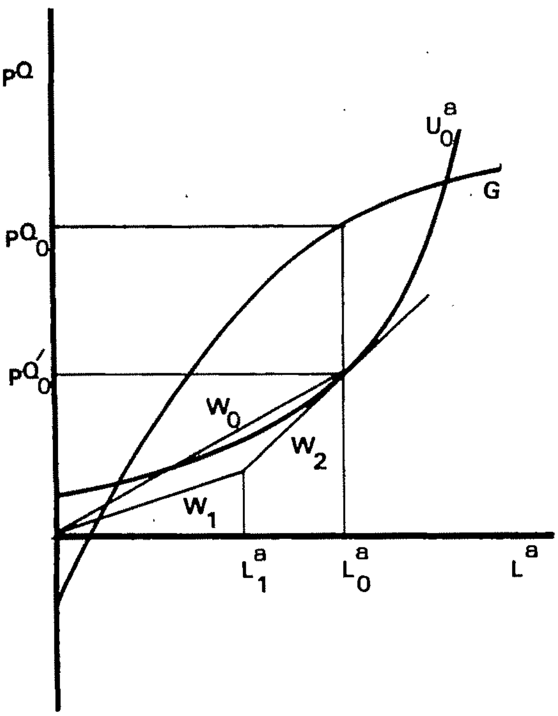

Figure 2. Optimal wage contracts

that the firm wishes to maximize profits. The desired level of output is Q_0 with $L^a = L_0{}^a$. Unless, by chance, the tangent to $U_0{}^a$ at $L_0{}^a$ passes through the origin, there does not exist a wage which will induce A to supply $L_0{}^a$ if he is allowed to choose his own supply.

On the other hand, it may be possible to induce A to supply $L_0{}^a$ by making him an all-or-nothing offer of pQ'_0 for $L_0{}^a$, a wage of $pQ'_0/L_0{}^a$ for $L^a = L_0{}^a$. Similarly, A will voluntarily choose to supply $L_0{}^a$ if he is offered a wage of w_1 for $L_1{}^a$ units of labor plus an overtime wage of w_2 for all units thereafter. In this case, $L_0{}^a$ is A's welfare-maximizing equilibrium. Similar comments apply to the welfare- and output-maximizing equilibriums given in figure 1. Any point on G can be reached by an appropriate all-or-nothing offer or by a system of regular and overtime wages.[4]

Despite its theoretical optimality, however, a wage system seems to have a number of practical drawbacks. First, the firm must enforce its labor contract in regard to both the quantity and quality of labor services. Large-scale agriculture provides an important case in point. Except at harvesting time, labor is not producing a standardized product that is easily monitored, and the results of whether a job has been done correctly may not be known for months. Furthermore, it is often inefficient to concentrate laborers into large groups which can be observed by an overseer. One response to this problem by the State Farms Corporation in Ghana, for example, has been to organize laborers into worker teams of as few as ten people supervised by one overseer who does not work himself. Possible problems are compounded by the fact that the overseer is paid a straight salary, giving him no great incentive not to take a nap in the hay.

A second problem, related to the first, is that an optimal wage system must link an individual's wage to his individual marginal product. This requires a correct appraisal of the productivity differences among workers and requires that the firm be allowed to pay different wages to different workers.[5] On state

[4] The present system prevailing in the Ghanaian State Farms Corporation and Food Production Corporation is very much like an all-or-nothing offer. The corporation pays the farm manager a salary and sets an output goal that the manager is expected to meet. If the manager fails to meet this goal, he may be fired. The conclusions of the analysis suggest that, under ideal circumstances, such a system can lead to optimal operation.

[5] Peter Knight has suggested that this is due to my neoclassical approach to the problem. I quote from his referee's report:

farms in many developing countries (such as Ghana), for example, a worker's wage is determined by his job and not by his performance on that job. The only difference in pay between two workers doing the same job is due to differences in seniority. Our results imply that this type of civil service reward structure is highly inappropriate for any firm regardless of what the firm's goals might be. But even when the wage system is completely flexible, optimality requires a good knowledge of each worker's contribution. Obtaining such information is costly, especially on a large farm, and in the end, managers can only make rough guesses as to the relative productivities of different workers.

A third problem faced by many firms and especially by state farms is embezzlement, particularly on food crop farms. It is very difficult to prevent this embezzlement in a wage system which gives workers no incentive not to embezzle and no incentive to police their fellow workers. With a relatively small amount of theft, a common laborer on a state farm in a developing country can double his salary. It is difficult to get a quantitative idea about the financial losses due to embezzlement, but individuals close to the scene consider it to be one of the principal difficulties of the Ghana Food Production Corporation (specialist in food crops).

Another problem that may arise in many firms and especially in large-scale agriculture involves machinery rental decisions in a wage labor situation. It can be argued that the rental decisions should not be left to a wage employee who does not have strong incentives to keep machinery expenditures at their optimal level.[6] We might expect that such an employee might hire capital up to the point where its marginal product is zero. This is similar to the problem of land use under certain types of contracts considered by Johnson. Some state farms have worked around this problem in a variety of ways while retaining straight wage systems. In Ghana's Food Production Corporation, for example, the decision regarding the number of tractors to be allocated to each farm is made at the corporate headquarters, but given the inevitable communications gap between farm and headquarters, such centralized decision making is also undesirable. It would seem reasonable that the individual who makes capital decisions should both have a close contact with the production process and have a direct incentive to make these decisions in a fashion consistent with the firm's goals.

Finally, wage systems can be faulted for failing to provide workers with any incentive to properly care for and maintain machinery. The threat of being fired is often the only incentive provided to operators and mechanics. At the same time, there is always that urge to finish a job a little more quickly and a little more casually than ought to be the case. This problem must be considered a major defect of a wage system, especially on state farms in developing countries where the opportunity cost of machinery (in terms of man-hours) is very high.

Profit-Sharing Organization

Since profit sharing may take many forms, this section attempts to develop a very general model that covers the more specialized cases. Related articles on profit sharing are by Ward (1957, 1958, 1965), Vanek (1965, 1970), Vanek and Espinosa, Kornai and Liptak, and Domar. Of particular interest are discussions by Ward (1958), Vanek (1965), and Vanek and Espinosa regarding the effects of worker management on the number of workers hired. Kornai and Liptak ask whether profit sum incentives or profit ratio incentives should be provided to a factory in order to induce the factory to respond to a variety of government goals.

The "firm," as entrepreneur, may claim a lump sum profit, Π, with revenues net of capital cost and Π being distributed among workers. Alternatively, it may claim some fraction $(1-\alpha)$ of output net of certain costs, with the remaining α equalling payments to workers. Consider the most general case in which the

"In the extreme, this results in the piecework system. Yet there is growing evidence that piecework may *impede* productivity increases as compared to collective incentive schemes—both in the static sense and even more so over time given the effect of mutual support and upgrading of skills as opposed to the antagonism of interpersonal competition within the firm."

[6] An overall optimum, of course, must involve optimal labor decisions and optimal capital decisions. Ideally, the corporation could make the capital decision and then expect the manager to meet an all-or-nothing offer with the quantity of capital provided by the corporation. This is the case in the Ghanaian State Farms Corporation and Food Production Corporation, where the farm is provided with the fixed amount of machinery according to the farm's acreage and crops produced. However, the practical facts are that machinery can be correctly used or abused. It is difficult to see how provision by the corporation of a fixed amount of machinery can lead to correct use and maintenance unless there are incentives to do so. In Ghana, unfortunately, tractors, etc. tend to be automatically replaced by the corporation when they "wear out."

firm claims a lump sum profit plus a percentage of output net of capital costs and lump sum profits. Payments to the firm equal $\Pi + (1-\alpha)(pQ - \Pi - rK)$ and payments to workers equal $\alpha(pQ - \Pi - rK)$. Further, assume that each worker is offered a fixed percentage of this latter amount. Denoting the percentage of this net output accruing to worker i as β^i, we have

$$\alpha(pQ-\Pi-rK) = \beta^a(pQ-\Pi-rK) + \beta^b(pQ-\Pi-rK), \tag{9}$$

where $\alpha = \beta^a + \beta^b$ by definition and where the optimal values of α and Π are found by solving equation (4), (5), or (7) as the case may be.[7]

Now assume that each worker behaves in a Cournot fashion, maximizing his own welfare with respect to the variables under his control, each acting independently and without reference to the other. In this case, the programming problem for the ith worker is

$$\max\ U^i(L^i, \beta^i(pQ-\Pi-rK)), \quad i = a, b \tag{10}$$
$$\text{subject to} \quad Q = F(L^a, L^b, K).$$

Assuming that worker i has control over how much capital is hired (e.g., assume that worker i is the firm manager), we can differentiate equation (10) with respect to L^i, Q, and K, the variables under his control:

$$dU^i = U_1^i dL^i + p\beta^i U_2^i dQ - r\beta^i U_2^i dK \tag{11}$$
$$dQ = F_i dL^i + F_3 dK, \qquad i = a, b.$$

An interior optimum requires dU^i to be zero for all differentials of dL^i, dQ, and dK. Substituting the second equation into the first and setting it equal to zero gives

$$\frac{U_1^i}{U_2^i} = -\,p\beta^i F_i, \qquad r = pF_3. \tag{12}$$

These conditions satisfy the requirements of equations (4) and (5) with regard to the efficient use of capital but do not satisfy the requirements with respect to the optimal provision of labor services.[8] Workers will set their marginal rates of substitution equal to the marginal product they receive. $\beta^i F_i$, and not to their total marginal product. *Ceteris paribus*, this type of behavior will lead workers to provide less than the optimal amount of labor.[9] Profit sharing of this type cannot produce an optimal allocation if workers do, in fact, behave this way. This is due to the fact the Cournot decision making ignores the obvious interdependence of their two labor decisions. Given these results, therefore, let us assume that capital is fixed and focus on this labor problem.

From such a Cournot solution, the possibility of mutual gains for both workers exists. We can analyze this problem by deriving a set of indifference curves for each worker in L^a, L^b space. Such an indifference curve is shown in figure 3 as U^{a*}; L^{a*}, worker A's optimal level of effort for $L^b = L^{b*}$ is the "bottom" point of U^{a*}. These indifference curves can be shown to have this general shape as follows: Let L^{a*} be worker A's optimal work effort for some level of worker B's effort, L^{b*}. The properties of the utility function and the behavioral assumption in equations (10), (11), and (12) are sufficient to show that, holding U constant at the level given by L^{a*}, L^{b*} equation (12) implies

$$\frac{dQ}{dL^a} \begin{cases} > F_1 \text{ at } L^a > L^{a*} \\ = F_1 \text{ at } L^a = L^{a*} \\ < F_1 \text{ at } L^a < L^{a*}. \end{cases} \tag{13}$$

Differentiating the production function gives

$$dQ = F_1 dL^a + F_2 dL^b, \tag{14}$$

and

$$\frac{dQ}{dL^a} = F_1 + F_2\left(\frac{dL^b}{dL^a}\right).$$

The relations in equation (13) are behavioral, while equation (14) is a technical relation which must hold everywhere.

We can ask, as we change L^a in the neighborhood of L^{a*}, how must L^b change in order to produce the change in Q—given in equation (14)—necessary to keep A at the same level of welfare—given in equation (13). Taken together, equations (13) and (14) imply that the slope of the indifference curve through L^{a*}, L^{b*} is

$$\frac{dL^b}{dL^a} \begin{cases} > 0 \text{ at } L^a > L^{a*} \\ = 0 \text{ at } L^a = L^{a*} \\ < 0 \text{ at } L^a < L^{a*} \end{cases} \tag{15}$$

[7] In practice, finding the optimal values of α and Π is no easier a task than finding the optimal wage offer. Since both problems require the same information, they are not dealt with here.

[8] The efficient use of capital depends, of course, on capital being a variable in the manner described in the model. If capital is provided exogenously (as in note 6), the conclusion does not follow.

[9] Readers will recognize that this problem is similar to the problem of output share contracts as discussed by a number of authors including Heady (1947) and Johnson (1950). It should be noted that their conclusions as to the nonoptimality of share contracts rest on the implicit assumption that landlord and tenant behave in a Cournot fashion.

In the general case, the assumption of a quasi-concave production function is not sufficient for these indifference curves to have the curvature illustrated. In the special case where labor is homogeneous such that $F(L^a, L^b, K) = F(L^a + L^b, K)$, quasi-concave utility and production functions are sufficient for the curvature as shown for $L^i > L^{i*}$. If the utility function of worker A is quasi-concave, we have

$$\frac{d^2Q}{d(L^a)^2} > 0.$$

From this, we can infer how L^a must change as we change L^b in order to produce this result. Differentiating the production function gives

$$\frac{d^2Q}{d(L^a)^2} = F_{11} + F_{12}\left(\frac{dL^b}{dL^a}\right) + F_{21}\left(\frac{dL^b}{dL^a}\right) + F_{22}\left(\frac{dL^b}{dL^a}\right)^2 + F_2\left(\frac{d^2(L^b)}{d(L^a)^2}\right).$$

If $Q = F(L^a + L^b, \bar{K})$ and if F is quasi-concave, a necessary condition for this technical derivative to be greater than zero for $L^a > L^{a*}$ is that

$$\frac{d^2(L^b)}{d(L^a)^2} > 0,$$

i.e., equal increments in L^a are met by increasing increments in L^b. This implies the positive curvature shown in figure 2 and similarly for worker B.

The set of L^{a*} for all L^b is the set of minimum point on worker A's indifference curves. This set is shown in figure 3 as AA′, which is often referred to as a reaction curve. It can be shown that this curve is negatively sloped if the production function is of the form $Q = F(L^a + L^b, K)$. Writing worker A's programming problem in Lagrangean form, we have

$$\max\ U^a(L^a, \beta^a Q) + \lambda(Q - F(L^a, L^b)).$$

Differentiating the first-order conditions, treating L^b as the independent variable, Cramer's rule yields

$$\frac{dL^a}{dL^b} = \frac{-\lambda F_{12} + F_2(U_{12}{}^a + F_1(U_{22}{}^a))}{|H|},$$

where $|H|$ is the Hessian matrix of the Lagrangean function, assumed to be positive if the second-order conditions hold. If $Q = F(L^a + L^b, \bar{K})$, and if F and U are quasi-concave, this derivative must be negative.

Similar curves can be derived for worker B;

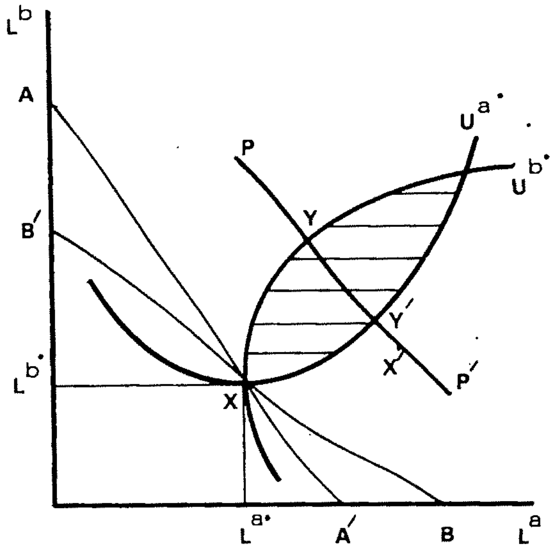

Figure 3. Cooperative and noncooperative profit-sharing outcomes

BB' is the set of optimal effort levels for worker B for each level of L^a. Cournot equilibrium, equation (12), is a point where each worker is putting forth his optimal effort given the effort of the other worker. Such a point must lie on both AA' and BB' as does point X in figure 3. Although point A need not be unique and although AA' and BB' may either not cross or cross in the opposite direction, we will assume for the remainder of the paper that a unique point X exists at positive levels of effort for each worker.

The welfare levels of workers A and B at the Cournot point X (also called the Nash equilibrium point of a cooperative game) are U^{a*} and U^{b*}, respectively. Since the slopes of U^{a*} and U^{b*} are unequal at X, it is necessarily true that the possibility of mutual gains exists for both workers. The set of L^a, L^b combinations which will make both workers better off than L^{a*}, L^{b*} at X is given by the hatched area enclosed by U^{a*} and U^{b*} in figure 3.

The Cournot solution is not optimal because the welfare interdependence of the two decision makers is not taken into account. We can analyze this interdependence as follows. Total differentiation of equation (10) gives

$$(16)\quad \begin{aligned} dU^a &= U_1{}^a dL^a + p\beta^a U_2{}^a dQ, \\ dU^b &= U_1{}^b dL^b + p\beta^b U_2{}^b dQ, \\ dQ &= F_1 dL^a + F_2 dL^b. \end{aligned}$$

Substituting the third equation into the first two,

$$(17)\quad dU^a = U_1{}^a dL^a + p\beta^a U_2{}^a F_1 dL^a + p\beta^a U_2{}^a F_2 dL^b$$
$$dU^b = U_1{}^b dL^b + p\beta^b U_2{}^b F_2 dL^b + p\beta^b U_2{}^b F_1 dL^a.$$

Now let us suppose that, recognizing their interdependence, our two workers wish to cooperate to improve their welfare by simultaneously raising their work effort above the Cournot level. Ruling out the possibility of side payments between workers, we postulate the following behavior model.

We assume that the two workers wish to enter into a cooperative agreement to increase their respective levels of work effort until they cannot find an additional pair of simultaneous effort changes which will make one of them better off without making the other one worse off. Outcomes to such cooperative agreements are simply points on the contract curve, given by PP' in figure 3. The set of cooperative solutions which makes them both better off relative to X is given by YY'. Although there may be many outcomes to such a cooperative agreement, we shall be content to examine the nature of the outcome and not worry about which of many possible solutions is picked.

In each of the equations in (17), the first two terms give the net cost to worker i of increasing his own labor while the third term gives the net benefit he receives from the increase in his partner's effort. A cooperative equilibrium will be reached at some level of effort when there does not exist a pair of differentials (dL^a, dL^b) which will make one worker better off without making the other one worse off, although some pair of differentials will leave the welfare of each worker unchanged. From equation (17), this gives us

$$(18)\quad \frac{U_1{}^a}{U_2{}^a} = -p\beta^a F_1\left(1 + \frac{F_2}{F_1}\frac{dL^b}{dL^a}\right)$$
$$\frac{U_1{}^b}{U_2{}^b} = -p\beta^b F_2\left(1 + \frac{F_1}{F_2}\frac{dL^a}{dL^b}\right),$$

where $\frac{dL^b}{dL^a}$ is the slope of the indifference curves at the tangency point on the contract curve.

Comparing equation (18) to equation (6), we see that the conditions characterizing a cooperative solution will generally not satisfy the requirements for an optimum. On the other hand, there may exist a value of dL^b/dL^a (there may exist a point on the contract curve) which will satisfy the conditions for an optimum. A necessary and sufficient condition for a solution (values for β^a, β^b, and dL^b/dL^a) to exist which satisfies the requirements for an optimum and satisfies the restrictions on β^a and β^b is that $\beta^a + \beta^b = 1$. If $\beta^a + \beta^b < 1$, no solution to equation (18) exists which is optimal.

We therefore conclude that if all output net of certain fixed costs is distributed between A and B ($\alpha = \beta^a + \beta^b = 1$), the optimum point will lie on the contract curve and cooperative behavior of the type described here may, by chance, produce an optimum. In other words, a requirement for optimality is that the workers collectively receive the full value of their marginal product, but such an outcome is not at all a certainty. Furthermore, even when a solution to equation (18) exists (i.e., a point on the contract curve exists) which satisfies the requirements for an optimum, there is nothing to imply that that solution makes both workers better off relative to the noncooperative equilibrium. For example, the solution might be a point such as X' in figure 3; X' is on the contract curve PP', but it is not on YY', that segment of the contract curve which makes both workers better off relative to X. In this case, X' cannot be an outcome of a cooperative process beginning at X.[10]

Distributive Shares Endogenous

It will now be shown that, in the special case where $\beta^a + \beta^b = 1$, the distributive shares β^a and β^b can be made endogenous in such a way that cooperative behavior of the type described above will always lead to an optimum.

When β^a and β^b are endogenous, the differentials in equation (17) become

$$(19)\quad dU^a = U_1{}^a dL^a + \beta^a U_2{}^a F_1 dL^a + \beta^a U_2{}^a F_2 dL^b + (pQ - \Pi - r\bar{K})U_2{}^a d\beta^a$$
$$dU^b = U_1{}^b dL^b + \beta^b U_2{}^b F_2 dL^b + \beta^b U_2{}^b F_1 dL^a + (pQ - \Pi - r\bar{K})U_2{}^b d\beta^b.$$

One reason that fixed shares profit sharing is generally not optimal even with cooperative behavior is that the fixed shares may be set at levels which fail to take into account the different preferences of the workers. Making distributive shares endogenous provides workers with an additional instrument for generating an optimal level of labor effort since they are not constrained by any arbitrary

[10] A more detailed and rigorous treatment of several points from this and the following section are given in Markusen (1974).

distribution rule. In particular, assume that they agree that as they change their labor efforts, the value of the change in A's share should equal the value to B of a change in L^a minus the value to A of a change in L^b. Under this system, for example, if A increases his effort with L^b held constant, β^a will increase at the expense of β^b. Similar comments apply to B. The change in β^a is then given by

$$(20)\quad (pQ - \Pi - r\bar{K})d\beta^a = p\beta^b F_1 dL^a - p\beta^a F_2 dL^b$$

$$d\beta^a = \frac{\beta^b F_1}{(pQ-\Pi-r\bar{K})}\,dL^a - \frac{\beta^a F_2}{(pQ-\Pi-r\bar{K})}\,dL^b.$$

Substituting these values into equation (19), the welfare differential becomes

$$(21)\quad dU^a = U_1{}^a dL^a + p\beta^a U_2{}^a F_1 dL^a + p\beta^a U_2{}^a F_2 dL^b + p\beta^b U_2{}^a F_1 dL^a - p\beta^a U_2{}^a F_2 dL^b = (U_1{}^a + p(\beta^a + \beta^b)U_2{}^a F_1)dL^a + p(\beta^a U_2{}^a F_2 - \beta^a U_2{}^a F_2)\,dL^b.$$

Similar equations hold for B. Worker A's welfare is now unchanged by dL^b and vice versa.

Letting dU^i equal zero for all differentials of dL^i gives

$$(22)\quad \frac{U_1{}^a}{U_2{}^a} = -\,p(\beta^a + \beta^b)F_1,$$

$$\frac{U_1{}^b}{U_2{}^b} = -\,p(\beta^a + \beta^b)F_2.$$

When $\beta^a + \beta^b = 1$, these conditions are identical to the optimum condition given in equation (6). Under these circumstances, cooperative behavior together with this type of endogenous distribution will produce an optimum.

It should be noted that the optimality conditions in equation (22) are necessary conditions for both profit and worker welfare maximizing. An implication here is that it is never optimal to take profit (or for the government to provide subsidies) as a percentage of output if the firm goal is profit or worker welfare maximization. Profits should be taken as a lump sum, implying that the optimal value of α is always equal to 1.[11]

It may seem that such a system of adjusting distributive shares is not a very realistic alternative. However, there does seem to be considerable evidence of successful self-managed firms in Yugoslavia and in other countries where workers do decide on distributive shares.

As a final theoretical point, profit sharing of this type will not be optimal if the firm's goal is to maximize output as in equation (8) above. Under no circumstances (cooperative behavior, endogenous distributive shares) will profit sharing lead to an equilibrium characterized by the conditions in equation (8). However, the government could institute an output price subsidy and a capital subsidy which, given cooperative behavior and endogenous distributive shares, would lead the firm to the satisfaction of the marginal rate of substitution and the value of the marginal product conditions given in equation (8). The MRS condition requires an *ad valorem* subsidy rate of $1/\lambda$ on output price. If such a subsidy is applied, the value of the marginal product condition in turn requires a subsidy of $(1 - \lambda)/\lambda$ on the rental rate (r).

Despite the theoretical drawbacks noted above, it can be argued that profit sharing presents a number of advantages over wage labor. First, as noted following equation (12), firm managers will tend to use capital efficiently (if they are charged the correct rate) in even the most simple profit-sharing system. At the same time, it is likely that machinery operators and mechanics will have more incentive to properly handle and maintain machinery when they are paid on a profit-sharing basis.

Regarding the supervision of labor, the need for such policing is probably reduced in a profit-sharing system, but more importantly, an incentive is created for laborers to police one another. Each laborer, unless he toils in Cournot ignorance, is aware that his reward will depend not only on his own efforts but the efforts of his fellow workers. Hopefully, this realization would lead to a cooperative and self-supervised work effort.

Similarly, profit sharing would likely reduce the embezzlement problem associated with wage systems. Individuals would still have an incentive to steal since their profit-sharing dividend would shrink by less than the amount of the theft. But at the same time, each individual has a strong incentive to prevent his fellow workers from embezzling. The self-supervising incentives of profit sharing are again valuable.

[11] This conclusion applies to profit sharing in the absence of endogenous distributive shares as well. It simplifies the programming problem for the central authority, which only needs to calculate the optimal value of Π. Once this figure is decided upon, the farm runs itself for better or worse, depending upon the degree of cooperation.

Several final comments are in order. As noted in the introduction, the scope of this paper has been purposely restrictive in order to treat a relatively narrow range of issues in a rigorous manner. The focus here has been strictly economic with little attention to social, political, or ideological variables. There can be no question that these other considerations must play a significant role in any firm's decision as to what type of reward structure to adopt. Such considerations may be of profound importance in developing countries in the process of deciding how to organize state enterprises in both the agricultural and nonagricultural sectors. The decisions that these countries make will not only affect the productivity of industry in a static sense, but by shaping the attitudes of the labor force, they may have an important impact on the level and the direction of economic growth. Indeed, as Peter Knight has pointed out to me, a prime reason for choosing collective incentive schemes over other alternatives is that through mutual workers' support and the upgrading of skills over time, the rate of firm growth may be increased.

Summary and Conclusions

The findings of this paper can be summarized in the following points. Reward structures based on straight wages or salaries, while offering theoretical advantages suffer from practical deficiencies. Labor contracts are difficult and costly to enforce, embezzlement is not discouraged, and there is no incentive for the optimal use and maintenance of capital equipment.

The results of the analysis clearly imply that civil service type wage systems which are not related to individual effort will prove to be inefficient relative to any goal. This may explain, in large part, the failure of state farms in Ghana and in other countries which organize their reward structures in this way. But more important, the results argue that the degree of agricultural efficiency can be substantially improved by simple and relatively costless forms of reorganization.

If a firm is organized on a pure profit-sharing basis of the type developed here, the decision problem for the workers can be characterized as a cooperative or nonzero sum game. The welfare of workers and firm profit will be improved to the extent that the workers cooperate.

A firm organized on this type of pure profit-sharing basis will generally not reach an optimum, even when workers cooperate, unless distributive shares are an endogenous variable. Even then, with a mechanism for determining distributive shares as outlined above, a necessary condition for an optimum is that all revenue net of fixed nonlabor costs be distributed among the workers. If the firm owners (or the state) takes its share as a percentage of revenue net of certain costs, an optimum will not be achieved. Profits should be taken as a lump sum.

When distributive shares are endogenous, a worker's reward depends upon not only the overall success of the firm but also upon the worker's effort relative to that of his fellow workers. As a general principle, therefore, we can suggest that an efficient profit-sharing system should employ such a two-part reward structure. A system equivalent to the one with endogenous distributive shares described here, for example, would pay workers a base salary plus a profit-sharing dividend. Workers' relative salaries would depend upon their relative productivity (arbitrary fixed wages will not do) and their profit-sharing dividends would depend upon the overall success of the firm. The optimality of such an equivalent system still depends, of course, on the conditions given in equations (3) and (4) above.

The government will generally be unable to induce a firm to maximize output given the type of profit-sharing structure described here, unless output price and capital costs are subsidized.

Reward structures based on profit sharing, while presenting theoretical difficulties, offer a number of practical advantages over a wage system. Laborers are more easily supervised, embezzlement is discouraged, optimal capital decisions are made, and workers are encouraged to use and maintain machinery with proper care. In addition, profit sharing may encourage workers to mutually support one another in an attempt to upgrade skills. This type of phenomenon has obvious implications for the growth of productivity over time and must be considered an important consideration for decisions about organizational forms in developing countries.

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The Rational Choice of Share Leasing and Implications for Efficiency

J. G. Sutinen

A formal statement of the theory of contractual choice is developed to derive conditions under which share leasing is rationally chosen. The allocative efficiency of share and nonshare leasing arrangements is compared under these conditions. Contrary to previous analyses, share leasing is shown to result in a higher expected level of farm output than otherwise. Therefore, land reform measures which restrict share leasing cannot be justified on grounds of improving productivity nor, as it turns out, on grounds of improving the sharecropper's welfare.

Key words: contractual choice, risk, share tenancy, land reform.

The literature on share leasing in agriculture can be divided into two general areas of investigation. There is a smaller portion on the theory of contractual choice which focuses on why and under what conditions share leasing is chosen, and there is a much larger portion concerning the efficient allocation of resources under share leasing. Unfortunately, these two obviously interrelated sets of conceptual issues have yet to be integrated. Since the assumptions used in the analysis of efficiency differ markedly from the assumptions used in the analysis of contractual choice, the need for such an integration is obvious.

The purpose of this paper is twofold. The first is to present a rigorous statement of the theory of contractual choice—including some marginal but relevant extensions of the received theory—and derive conditions under which share leasing would rationally be chosen. The second is to compare the allocative efficiency of share and nonshare leasing under these derived conditions. The result is a fully integrated, formal analysis of share leasing which yields conclusions and policy implications that are markedly and interestingly different from the received theory of share leasing.

During a lengthy discussion of share leasing in this *Journal* a few years ago (Adams and Rask 1968, 1969, 1970; Boxley 1971, 1972; Gisser; Kim; Scott), Boxley (1971, 1972) ably presented and defended a model which challenges the traditional claim that share leasing in agriculture results in an inefficient allocation of resources.[1] His analysis was based on a theory first developed by Cheung and concludes that share leasing instead results in an efficient allocation of resources identical to the competitive allocation implied by standard, nonshare leasing arrangements.

This paper challenges both the traditional claim and the Cheung-Boxley position. The principal conclusion is that, when rationally chosen, share leasing is more efficient than nonshare leasing and results in a higher expected level of farm output than otherwise. Thus, the efficiency implications of share leasing differ substantially from both the traditional and Cheung theories.

In those situations where the realities of the world do not violate the assumptions of the analysis, the implications for policy are that legislation restricting share leasing cannot be justified on the grounds of improved efficiency nor on the grounds of improving the sharecropper's welfare, as some have done (Adams and Rask 1968, p. 941). The theory here argues that while in some cases of share restriction the sharecropper's expected income is increased, his expected utility, and thus his level of welfare, remains unchanged. Furthermore,

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[1] As is well known, economists since Adam Smith have been concerned with the allocative efficiency of share leasing. Cheung, Johnson, and Reid survey the older share-leasing literature.

the landlord is always made worse off by a share restriction.

The Role of Share Leasing in Economic Organization

Share leasing is an aspect of the structure of the firm. When production costs for a given level of output can be reduced by combining the resources of more than one owner, those owners may arrive at an agreement with the firm whereby some of the rights of use of the resources in the productive process are transferred to the firm under specified conditions covering the method and amount of remuneration to the owners (Coase). When such payment is based on a share or proportion of the value of output, the resulting agreement is described as a share lease or contract. Under this arrangement the resource (for example, labor) receives a contractually established proportion of the actual value of output as payment for its services as opposed to receiving a wage for every unit of services supplied under a wage contract.

A major role of share leasing is that of distributing risk. A standard economic textbook view of the firm has the entrepreneur assuming the risk of uncertainty, either enjoying the firm's profits or suffering its losses (Friedman, p. 99). As Arrow has observed, however, institutions exist in the modern world which allow the entrepreneur to shed much of the risk associated with the firm's economic activity. Obvious examples of such risk-shifting media are fire and marine insurance, commodity futures markets, and the issuance of stock which allows entrepreneurs to avoid some of the risk by permitting outsiders to share in the firm's profits and losses. Share leasing also permits the entrepreneur to avoid some of the risk by sharing the residual income of the firm with other parties.

For example, if the whole of labor's remuneration is based on a percentage of the actual value of output, then labor shares with the entrepreneur the residual income of the firm and bears a portion of the risk inherent in the economic activity of the firm. By definition, each party to the share contract receives a specified proportion of the actual value of output. The proportion of the value of output a party receives is also the proportion of the variation in the value of output the party assumes. Let $Y + \epsilon =$ the actual value of output, where $Y =$ the expected value of output and ϵ = a random variate. If $r =$ the proportion of the value of output received by the entrepreneur and $(1 - r) =$ the proportion received by labor, then $Y + \epsilon = r(Y + \epsilon) + (1 - r)(Y + \epsilon)$. The share of the variation in the value of output assumed by the entrepreneur is $r\epsilon$ and by labor $(1 - r)\epsilon$. Share leasing has thus spread the risk of uncertainty among the parties, and such a capability is a dominant factor in the theory of contractual choice.

A Theory of Contractual Choice

The purpose of this section is to present a rigorous statement of the theory of contractual choice and to generate conditions under which the resource allocation of share and nonshare leasing can be compared. The statement here extends the received theory (Cheung, Rao, Huang) by allowing for a larger set of contractual arrangements than previously considered and by explicitly establishing the necessary conditions for the rational choice of share leasing.

The assumptions are as follows. (*a*) All markets are competitive and the rights to all property are private.[2] (*b*) The farm is owned and organized by a landlord possessing a fixed amount of land. (*c*) A large number of potential sharecroppers exist and they have identical utility functions. The landlord and each sharecropper are assumed to have continuous concave utility functions U_1 and U_2, respectively; $U''_1 < 0$ and $U''_2 < 0$, each individual being risk averse. (*d*) The landlord has under his control the expected level of output, i.e., he is responsible for negotiating and enforcing the contracts specifying the terms of employment for the factors of production, including remuneration and the quantity of each factor to be employed. (For evidence justifying this assumption see Cheung, pp. 76–79; Reid; Johnson, p. 118.) (*e*) Total revenue is equal to $pq\mu$, where μ is a nonnegative random variable interpreted to reflect variations of natural factors of production (e.g., weather), variations of the price of output, or some combination of both. The expected value of μ is one and of price and quantity of output, p and q, respectively. (*f*) Transaction costs (i.e., the

[2] This is a simplifying assumption. As shown in note 13, the principal results of this paper also hold for the monopolistic case; however, treatment of other instances of imperfect competition is beyond the scope of this paper.

costs of negotiating and enforcing the terms of the lease) are negligible, and all other means for transferring the risk inherent in the production activity are prohibitively costly.[3] (g) Let the income of the landlord and of the sharecropper, respectively, be given by $\pi = rpq\mu - \Theta$, and $\phi = (1 - r)pq\mu - C(q) + \Theta$, where r = the landlord's proportion of the actual value of output, and $(1 - r)$ = the sharecropper's proportion (therefore, $0 \leq r \leq 1$). The amount of the landowner's outlay or remuneration, aside from his share of the gross revenue, is represented by Θ. As should become clear from the following analysis, Θ is a shift variable which acts to adjust the sharecropper's expected income to a level where he is indifferent about employing his assets in this farming activity or elsewhere in the economy. And $\Theta \gtreqless 0$ are all possible.[4] Total variable costs of producing an expected level of output are represented by $C(q)$, where it is assumed that $C' > 0$ and $C'' > 0$.[5] The net income of the landlord is represented by π. The sharecropper's net income, ϕ, is payment for the services of his assets which are assumed to be fixed (e.g., managerial skills),[6] and for his risk-bearing services.

Under the above conditions, the landlord is assumed to maximize his expected utility of income by choosing a set of terms or arrangements (r, Θ, and q) which will induce a second party to sign the lease. In a world of private property rights in which the potential sharecroppers are free to accept or reject the terms of a lease, the landlord is constrained by the condition that a sharecropper in this activity be made no worse off than if he employed his assets elsewhere in the economy. In a world of competition, the sharecropper also will be made no better off in this activity; otherwise, competing sharecroppers will offer their services for less and such competition will ensue until the sharecropper is just indifferent as to employing his assets in this activity or elsewhere in the economy. Therefore, the landlord is constrained to offer terms which ensure that the expected utility of a sharecropper's income from this activity equal his expected utility of income when his assets are employed elsewhere in the economy.

Formally, the problem is to maximize $E\{U_1(\pi)\}$ subject to $E\{U_2(\phi)\} = E\{U_2(I)\}$, where E is the expectation operator, U_1 and U_2 are the utility functions for the landlord and sharecropper, respectively, and I is the amount of income that could be realized if the sharecropper employed his assets elsewhere in the economy. The income I may or may not be certain;[7] however, $E\{U_2(I)\}$ is determined outside the problem at hand and will be considered to equal some constant value, $\bar{U}_2$.

The landlord maximizes over the variables r, Θ, and q. In terms of the Lagrangean,

$$\max_{(r,\Theta,q,\lambda)} L = E\{U_1[rpq\mu - \Theta]\} + \lambda[E\{U_2[(1 - r)pq\mu - C(q) + \Theta]\} - \bar{U}_2].$$

The first-order conditions are

$$(1) \quad L_r = E\{U'_1(\pi)(pq\mu)\} + \lambda E\{U'_2(\phi)(-pq\mu)\} = 0,$$

$$(2) \quad L_\Theta = E\{U'_1(\pi)(-1)\} + \lambda E\{U'_2(\phi)\} = 0,$$

$$(3) \quad L_q = E\{U'_1(\pi)(rp\mu)\} + \lambda E\{U'_2(\phi)[(1 - r)p\mu - C'(q)]\} = 0,$$

and

$$(4) \quad L_\lambda = E\{U_2(\phi)\} - \bar{U}_2 = 0.$$

Equations (1)–(4), the necessary conditions for a maximum, are now examined to determine the conditions under which the landlord will choose, and the sharecropper accept, a share lease. The procedure is to impose standard, nonshare leasing arrangements on the landlord and ascertain whether he would be made worse off than under a share lease.

First, the value of $r = 1$ is imposed on the landlord. In this case all of the risk is borne by the landlord. From the constraint, equation (4), which must always hold, $\Theta = I + C(q)$. Incomes are given by

$$\pi|_{r=1} = pq\mu - C(q) - I,$$
$$\phi|_{r=1} = I,$$

and substituted into the first-order conditions. From equation (2),

[3] Although necessary for his results, Cheung does not explicitly exclude the availability of other risk-shifting media.

[4] Including Θ is an important extension of received theory. First, it allows a more general formulation of available leasing arrangements and, second, without the choice of Θ, an optimum share, r, will not generally exist. For more on this second point, see Sutinen (chap. 3).

[5] Deducting $C(q)$ from the sharecropper's share of gross revenue is referred to in the literature as a "traditional lease" (Adams and Rask 1968, p. 935). Deducting $C(q)$ from gross revenue before sharing is termed an "ideal lease" because it allegedly results in an efficient allocation of resources whereas the traditional does not. The conclusions derived here are independent of such a distinction, that is, in this model an ideal share lease results in the same allocation of resources as a traditional share lease.

[6] For the case where the sharecropper as laborer is allowed to work part-time in this activity and part-time elsewhere at the market wage rate, see Sutinen.

[7] If random, I is assumed to be independent of μ.

$$\lambda = \frac{E\{U'_1(\pi|_{r=1})\}}{E\{U'_2(\phi|_{r=1})\}} = \frac{E\{U'_1(\pi|_{r=1})\}}{E\{U'_2(I)\}}.$$

Substituting for λ in equation (1), the first-order condition determining r can be written as

$$(5) \quad pq[E\{U'_1(\pi|_{r=1})\mu\} - E\{U'_1(\pi|_{r=1})\}\,E\{\mu\}] = 0.$$

This equality, however, does not hold since the expression in brackets is negative. To prove this assertion rewrite

$$U'_1(\pi|_{r=1}) = U'_1(\mu),$$

since μ is the variable of concern. Therefore,

$$E\{U'_1(\pi|_{r=1})\mu\} - E\{U'_1(\pi|_{r=1})\}\,E\{\mu\} = E\{U'_1(\mu)\mu\} - E\{U'_1(\mu)\}\,E\{\mu\},$$

the right-hand side of which can be expanded to

$$E\{U'_1(\mu)\mu\} - U'_1(E\{\mu\})\,E\{\mu\} - E\{U'_1(\mu)\}\,E\{\mu\} + U'_1(E\{\mu\})\,E\{\mu\}$$

and then condensed to equal

$$(6) \quad E\{[\mu - E\{\mu\}]\,[U'_1(\mu) - U'_1(E\{\mu\})]\}.$$

The expression

$$(7) \quad [\mu - E\{\mu\}]\,[U'_1(\mu) - U'_1(E\{\mu\})]$$

is negative when $\mu < E\{\mu\}$ as then $\mu - E\{\mu\} < 0$ and $U'_1(\mu) - U'_1(E\{\mu\}) > 0$, because $U''_1 < 0$. It is also negative when $\mu > E\{\mu\}$ as then $\mu - E\{\mu\} > 0$ and $U'_1(\mu) - U'_1(E\{\mu\}) < 0$, again because $U''_1 < 0$. Of course, when $\mu = E\{\mu\}$ this expression equals zero. However, since there is a positive probability that $\mu \neq E\{\mu\}$, the expected value of equation (7), i.e., equation (6) is less than zero, and the first first-order condition is not satisfied.[8] Therefore, the landlord will not choose $r = 1$ and $\Theta = I + C(q)$ as the optimum set of leasing arrangements.

The other set of nonshare leasing arrangements to be imposed on the landlord are where $r = 0$ and $\Theta \gtreqless 0$. (Although $\pi = 0$ when $\Theta = 0$, the landlord is still paid for the use of his land since $C(q)$ includes the opportunity cost of all inputs supplied by the landlord.) Substituting these values into equations (1)–(4), incomes become

$$\pi|_{r=0} = -\Theta,$$
$$\phi|_{r=0} = pq\mu - C(q) + \Theta$$

and, following the same procedure as above, from equation (2),

$$\lambda = \frac{E\{U'_1(\pi|_{r=0})\}}{E\{U'_2(\phi|_{r=0})\}}.$$

Substituting for λ and rearranging terms, the left-hand side of equation (1) becomes

$$-\,pq\,E\{U'_1(\pi|_{r=0})\}[E\{U'_2(\phi|_{r=0})\,\mu\} - E\{U'_2(\phi|_{r=0})\}\,E\{\mu\}].$$

This expression is greater than zero, since the term in brackets is negative by the same argument as the bracketed term in equation (5) is negative.

Again, the first first-order condition is not satisfied, implying the landowner will not choose these leasing arrangements. These results imply that the optimum share, r^*, lies between zero and one. Since the first first-order condition is negative when $r = 1$ and positive when $r = 0$, i.e.,

$$L_r|_{r=1} < 0,\; L_r|_{r=0} > 0,$$

the value of the objective function obtains a maximum in the range $0 < r < 1$. Given this range on r, the constraint, which holds in all cases, requires $\Theta < I + C(q)$. Therefore, the rational landlord seeking to maximize his expected utility of income under conditions (*a*)–(*g*) above will elect some form of share leasing.

As one would expect, this conclusion changes when the conditions change. When there is no risk (μ = a constant) or the parties to the lease are risk neutral ($U''_1 = U''_2 = 0$), the landlord exhibits indifference towards share and nonshare lease arrangements. Should transaction costs be significantly positive and greater for share leasing than for nonshare leasing, then, as Cheung argues (p. 69), a share lease may not be preferred even when risk and risk aversion exist. Alternatively, should transaction costs be less, a share lease may be preferred even when risk and risk aversion do not exist.[9]

Also, if other competitive (in terms of cost) means exist for shifting some of the risk away from the landlord (e.g., futures markets and

[8] The other first-order conditions are easily shown to be satisfied.

[9] The issue is an empirical one. Transaction costs consist of the costs associated with negotiating and enforcing the terms of the lease. Intuition suggests that negotiation costs are higher for a share lease than for a rental or wage contract (since the items to negotiate for a share lease—the share, fixed payment, and levels of inputs—may be more complex than for other contracts) and that enforcement costs are lower the greater the share received by the sharecropper (since he has an incentive to produce more, the greater his share). If this speculation is valid, the higher negotiation costs would tend to induce less share leasing while the lower enforcement costs would tend to induce more share leasing. Therefore, it is not possible to say, a priori, how positive transaction costs affect the extent to which share leasing is chosen.

crop insurance), a share lease may not be chosen. The existence in the modern world of both nonnegligible transaction costs and other means of risk shifting go a long way to explain why risk averse landlords do not choose share leasing in the face of risk.

Share Leasing and the Allocation of Resources

The purpose of this section is to demonstrate that when rationally chosen, share leasing is more efficient than nonshare leasing and results in a greater level of output than otherwise.

Although this result can be derived for the general case (Sutinen, chap. 3), the author believes it is more instructive as well as less complex to assume specific functional forms for the utility functions and a specific probability law for the random variable. Therefore, let

$$U_1(\pi) = -e^{-\alpha\pi} \text{ and } U_2(\phi) = -e^{-\beta\phi},$$

where α and β and positive parameters,[10] and let μ follow the gamma probability law, i.e., its probability density function is

$$f(\mu) = \frac{\Lambda^\rho}{\Gamma(\rho)}\mu^{\rho-1}e^{-\Lambda\mu} \text{ for } \mu \geq 0,$$

with parameters $\rho = 1,2,\ldots$ and $\Lambda > 0$ (Parzen, p. 180). With these functions,

$$\begin{aligned} E\{U_1(\pi)\} &= -\int_0^\infty e^{-\alpha\pi}f(\mu)d\mu \\ &= -\frac{\Lambda^\rho}{\Gamma(\rho)}\int_0^\infty e^{-\alpha[rpq\mu-\theta]-\Lambda\mu}\mu^{\rho-1}d\mu, \\ &= -\frac{\Lambda^\rho}{\Gamma(\rho)}e^{\alpha\theta}\int_0^\infty e^{-\mu[\alpha rpq+\Lambda]}\mu^{\rho-1}d\mu, \\ &= -\frac{\Lambda^\rho}{\Gamma(\rho)}e^{\alpha\theta}\frac{\Gamma(\rho)}{[\alpha rpq+\Lambda]^\rho},^{11} \\ &= -\frac{\Lambda^\rho e^{\alpha\theta}}{[\alpha rpq+\Lambda]^\rho}. \end{aligned}$$

Similarly,

$$E\{U_2(\phi)\} = -\frac{\Lambda^\rho e^{\beta[C(q)-\theta]}}{[\beta(1-r)pq+\Lambda]^\rho},$$

and $E\{U_2(I)\} = -e^{-\beta I}$, where I is a constant.

To maximize $E\{U_1(\pi)\}$ subject to $E\{U_2(\phi)\} = E\{U_2(I)\}$ in this case, the Lagrangean is

$$\max_{\{r,\theta,q,\lambda\}} L = -\Lambda^\rho[\alpha rpq+\Lambda]^{-\rho}e^{\alpha\theta} + \lambda\{\Lambda^\rho[\beta(1-r)pq+\Lambda]^{-\rho}e^{\beta[C(q)-\theta]} - e^{-\beta I}\}.$$

The first-order conditions are

$$(8)\quad L_r = -\Lambda^\rho(-\rho)(\alpha pq)[\alpha rpq+\Lambda]^{-\rho-1}e^{\alpha\theta} + \lambda\Lambda^\rho(-\rho)(-\beta pq)[\beta(1-r)pq+\Lambda]^{-\rho-1} e^{\beta[C(q)-\theta]} = 0,$$

$$(9)\quad L_\theta = -\Lambda^\rho\alpha[\alpha rpq+\Lambda]^{-\rho}e^{\alpha\theta} + \lambda\Lambda^\rho(-\beta)[\beta(1-r)pq+\Lambda]^{-\rho}e^{\beta[C(q)-\theta]} = 0,$$

$$(10)\quad L_q = -\Lambda^\rho(-\rho)(\alpha rp)[\alpha rpq+\Lambda]^{-\rho-1}e^{\alpha\theta} + \lambda\Lambda^\rho(-\rho)[\beta(1-r)p] [\beta(1-r)pq+\Lambda]^{-\rho-1}e^{\beta[C(q)-\theta]} + \lambda\Lambda^\rho[\beta C'(q)][\beta(1-r)pq+\Lambda]^{-\rho} e^{\beta[C(q)-\theta]} = 0,$$

and

$$(11)\quad L_\lambda = \Lambda^\rho[\beta(1-r)pq+\Lambda]^{-\rho}e^{\beta[C(q)-\theta]} - e^{-\beta I} = 0.$$

Using equations (8) and (9), λ can be eliminated and the optimal r solved for in terms of the parameters of the utility functions, that is,

$$(12)\qquad r^* = \frac{\beta}{\alpha+\beta}.$$

Since $\alpha > 0$ and $\beta > 0$, $0 < r^* < 1$. Also α and β are measures of absolute risk aversion of the landlord and the sharecropper, respectively.[12] Therefore, if each is equally as risk averse, i.e., $\alpha = \beta$, then $r^* = 0.5$ and they share in the risk equally. And if one party is less risk averse than the other, he will bear a larger portion of the risk than the other. For example, if $\alpha < \beta$, $r > 0.5$ and the landlord bears more than half of the variation in total revenue.

Again, solving for λ in equations (8) and (9), substituting the results into equation (10) and rearranging terms yields

[10] Admittedly, these utility functions are not completely satisfactory for the analysis of economic behavior under risk. They have the characteristics of constant absolute risk aversion and increasing relative risk aversion whereas increasing absolute and constant relative risk aversion are generally more desirable. (For discussions of these characteristics and their economic implications see Arrow, Pratt, Stiglitz.) These shortcomings have no significant implications for the issues at hand, however, and the implications they do have will be mentioned in note 12.

[11] This reduction is the result of the use of a familiar LaPlace transform. See Parzen (p. 165, ex. 2.1).

[12] Arrow and Pratt define the measure of absolute risk aversion to equal $-U''/U'$. If utility functions with constant absolute risk aversion had not been assumed, one would expect the parameters of the probability distribution and levels of expected income to enter also. The qualitative nature of the results derived here would remain unchanged; however, it is likely that at greater levels of risk the landlord would be induced to spread a greater share over a larger number of sharecroppers. Also, with decreasing absolute risk aversion a sharecropper would be willing to assume a greater portion of the risk for a given premium, the greater his opportunity cost.

$$(13) \qquad p = \frac{[\alpha rpq + \Lambda]}{\rho} \cdot C'(q),$$

where p = expected output price, and $C'(q)$ = marginal cost of the expected level of output. Since $E\{\mu\} = \rho/\lambda = 1$, then

$$\frac{[\alpha rpq + \lambda]}{\rho} > 1.$$

Therefore, the equilibrium expected level of output is chosen such that expected price is greater than marginal cost.

Solving equation (11) for Θ yields

$$(14) \quad \Theta = I + C(q) + (\rho/\beta)\ln \Lambda - (\rho/\beta)\ln[\beta(1 - r)pq + \Lambda].$$

Equation (14) reveals that, as expected, Θ can be greater than, less than, or equal to zero, and that a larger opportunity cost, I, of the sharecropper's assets implies a larger Θ, i.e., either a larger fixed payment to the sharecropper by the landowner or a smaller fixed payment to the landowner by the sharecropper.

The three equations, (12), (13), and (14), can be solved for the optimum values of r, Θ, and q in terms of the parameters p, α, β, ρ, Λ, and I. To compare the allocative efficiency of share to nonshare leasing, equations analogous to (12), (13), and (14) are derived next when $r = 1$ and when $r = 0$. In these instances, r is not a choice variable and the first first-order condition is not required to hold. Therefore, equations (9), (10), and (11) yield

$$(15) \qquad r = 1,$$

$$(16) \qquad p = \frac{[\alpha pq + \Lambda]}{\rho} C'(q),$$

$$(17) \qquad \Theta = I + C(q),$$

or

$$(18) \qquad r = 0,$$

$$(19) \qquad p = \frac{[\beta pq + \Lambda]}{\rho} C'(q),$$

$$(20) \quad \Theta = I + C(q) + (\rho/\beta)\ln \Lambda - (\rho/\beta)\ln[\beta pq + \Lambda].$$

Comparing equations (13), (16), and (19), the wedge between expected price and marginal cost is different in each case. Substituting equation (12) into equation (13) allows a direct comparison. Since

$$\frac{\alpha\beta}{\alpha + \beta} < \alpha \text{ and } \frac{\alpha\beta}{\alpha + \beta} < \beta,$$

the wedge required between expected price and marginal cost at any given expected level of output is smaller for $0 < r^* < 1$ than for $r = 1$ and $r = 0$. Therefore, with increasing marginal cost, a share lease allows for a greater level of expected output nearer to that level which would equate expected price with marginal cost than a nonshare lease would permit.[13]

The examples presented in table 1 illustrate these and other results. For this exercise the total cost function is assumed to be $C(q) = 0.04q^2$; hence the marginal cost function is $C'(q) = 0.08q$. The left-hand side of the table specifies alternative values of the exogenous variables of the model, while the right-hand side lists the solution values of the expected level of output, q, the terms of the lease, r and Θ, the expected incomes, $E\{\phi\}$ and $E\{\pi\}$, total costs, $C(q)$, and expected total revenue, pq.

If there were no risk or no risk aversion in the model, the expected level of output would be $q = 125$; no share arrangement would be preferred over another, $E\{\phi\} = 100$ and $E\{\pi\} = 525$. With the existence of risk, as specified by ρ and Λ, and the existence of risk aversion, as specified by α and β, the expected level of output in example 1 is reduced to 80% of the no risk-no risk aversion level. This reduction in the expected level of output is due to the existence of risk and risk aversion and not due to share leasing. A comparison of examples 2 and 3 with example 1 shows that when nonshare leasing is imposed (i.e., setting $r = 1$ and $r = 0$), the expected level of output is further reduced. This is a clear demonstration of the superior efficiency of share leasing.

If either or both parties are more averse to risk than in example 1, the expected level of output is smaller still (see examples 4, 6, and 8). And when nonshare leasing is imposed such that the more risk averse party must bear all the risk, output is further reduced by a substantial amount (see examples 5 and 7).

The effect on expected output of changes in the level of risk is illustrated in examples 9 and 10. The level of risk is increased (decreased) by

[13] To show that this result holds for the monopolistic case, let $pq = R(q)$. Comparable expressions for equations (13), (16), and (19) are, respectively,

$$R'(q) = \frac{[\alpha rpq + \Lambda]}{\rho} C'(q), \; 0 < r < 1;$$

$$R'(q) = \frac{[\alpha pq + \Lambda]}{\rho} C'(q), \; r = 1;$$

and

$$R'(q) = \frac{[\beta pq + \Lambda]}{\rho} C'(q), \; r = 0. \quad \text{Q.E.D.}$$

Table 1. Expected Levels of Output and Incomes under Alternative Leasing Arrangements, Risk Aversion Measures, and Risk Levels

	Exogenous Variables[a]						Endogenous Variables[b]						
Example	p	α	β	ρ	Λ	I	q	r	Θ	$E\{\phi\}$	$E\{\pi\}$	$C(q)$	pq
1	10	0.01	0.01	20	20	100	100	1/2	53.71	153.71	446.29	400.00	1000.00
2	10	0.01	0.01	20	20	100	87	1[c]	402.76	100.00	467.24	302.76	870.00
3	10	0.01	0.01	20	20	100	87	0[c]	−319.57	247.67	319.57	302.76	870.00
4	10	0.02	0.01	20	20	100	95	1/3	−89.21	183.13	405.87	361.00	950.00
5	10	0.02	0.01	20	20	100	72	1[c]	307.36	100.00	412.64	207.36	720.00
6	10	0.01	0.02	20	20	100	95	2/3	185.90	141.56	447.44	361.00	950.00
7	10	0.01	0.02	20	20	100	72	0[c]	−234.96	277.68	234.96	207.36	720.00
8	10	0.02	0.02	20	20	100	87	1/2	41.60	173.84	393.40	302.76	870.00
9	10	0.01	0.01	18	18	100	98	1/2	50.78	156.62	439.22	384.16	980.00
10	10	0.01	0.01	22	22	100	102	1/2	57.48	151.32	452.52	416.16	1020.00
11	10	0.01	0.01	20	20	110	100	1/2	63.71	163.71	436.29	400.00	1000.00
12	11	0.01	0.01	20	20	100	106	1/2	37.83	171.39	545.17	449.44	1166.00

[a] p = product price; α and β are measures of absolute risk aversion for landlord and sharecropper, respectively; ρ and Λ are parameters of the random variate's probability distribution; and I = the opportunity cost of the sharecropper's assets.
[b] q = expected output level; r = the share; Θ = the fixed payment; $E\{\phi\}$ and $E\{\pi\}$ are the expected incomes for sharecropper and landlord, respectively; $C(q)$ = total costs; pq = expected total revenue.
[c] Imposed values.

widening (narrowing) the spread of μ's distribution while holding its mean constant.[14] (For a formal definition of increasing risk, see Rothschild and Stiglitz.) The increased level of risk in example 9 results in a smaller expected output level as compared to example 1, and decreased risk in example 10 results in a greater expected output level.

The share r, except when imposed on the parties, is determined by the parameters of risk aversion, α and β. In example 4, the lower share reflects the landlord's greater aversion to risk, and the higher share in example 6 reflects the sharecropper's greater aversion to risk.

The variable Θ does nothing more than adjust the sharecropper's expected income to where he is indifferent between employing his assets in this farming activity and elsewhere in the economy. Clearly $\Theta \gtreqless 0$ are all possible.

The sharecropper is being paid \$53.71 above his opportunity cost for the risk he is bearing in example 1. In all examples except 11 the sharecropper remains at the same level of expected utility. Therefore, even though the imposed nonshare lease in example 7 raises his expected income to almost three times his opportunity cost, the sharecropper is made neither better nor worse off. In example 4 the sharecropper bears two-thirds of the variation in gross revenue and is paid a larger risk premium (\$83.13) for his services.

The sharecropper's marginal risk premium can be observed by comparing $E\{\phi\}$ in examples 9 and 10 with $E\{\phi\}$ in example 1. In all examples the variance of μ is $\sigma^2 = 0.050$, except in example 9 where $\sigma^2 = 0.056$ and in example 10 where $\sigma^2 = 0.045$. The sharecropper demands an additional \$2.91 for the additional risk he faces in example 9 and demands \$2.39 less for the smaller amount of risk faced in example 10.

In example 11 the opportunity cost of the sharecropper's assets is greater, resulting in a higher expected income for him and a lower expected income for the landlord. The expected level of output does not change, which is due to the assumption holding the sharecropper's services constant. Allowing his services to be variable has been ignored in order to achieve greater simplicity of exposition and calculation. The principal results of this paper remain unaltered by this simplification.

Example 12 demonstrates the effects of an increase in the expected price of output. Output increases as a result, as does the risk premium required by the sharecropper which is due to the fact that risk—in this formulation—is greater at higher expected levels of output.

The landlord is at a higher level of expected utility with a share lease. Therefore, even though his expected income in example 2 is greater than in example 1, it is not sufficient to reimburse him for the added risk he faces under the nonshare lease. The last four columns of table 1 show that the sum of expected incomes and costs equal the total expected revenues from the farm.

[14] Note that the mean and variance of μ are given by ρ/Λ and ρ/Λ^2, respectively.

Concluding Remarks

For almost two centuries economists have held that share leasing leads to economic inefficiency. Contrary to this, the theory in this paper demonstrates that when rationally chosen, share leasing can result in a more efficient allocation of resources and a greater expected level of output than nonshare leasing arrangements.

The economic logic of this result is straightforward. The landlord as farmer is engaged in a risky income-producing activity. His crop production is subject to variations in the weather, and the price he receives may fluctuate as market conditions change. To bear the entire risk himself is not his best alternative. Rather, one would expect the landlord to select that available alternative which minimizes the cost of risk bearing at a given level of output. If the landlord chooses a share lease, the cost of having the sharecropper bear some portion of the risk must be less than the cost of any other risk-shifting alternative. In other words, when chosen, the share lease is the least-cost means of spreading the risk. Therefore, the unit cost of production is lower with a share lease which implies a higher expected level of output and input utilization than otherwise.

A theory is rarely without some weaknesses and, as has been indicated above for some issues, the theory in this paper is no exception. A number of researchers in this area have been concerned with explaining the incidence of sharecropping (Bardhan and Sirnivasan, Cheung, Huang, Rao, Reid). Although the theory developed here provides some insights into this issue, no hypotheses emerge that can be tested on quantitative data. A more complete theory for this purpose would allow for transaction costs and the cost of alternative risk-sharing mechanisms.[15] For example, it is likely that technological advances and general development have reduced the inherent risk faced by the farmer by introducing new production techniques and have provided him with additional mechanisms for spreading risk. The simple model developed in the third section is not capable of handling such changes, however, and further work is required before this issue is settled conclusively.

Some meaningful conclusions from this theory can be drawn, however. Land reform programs in Japan (Adams and Rask 1968, p. 941), the Philippines (Ruttan), Taiwan (Cheung, chaps. 5–8), and elsewhere have restricted the shares received by the landlords or simply forbidden the use of share leasing altogether. Ruttan has argued in favor of such reforms, concluding that "productivity . . . is facilitated by the conversion from share tenancy to a leasehold system based on a fixed rental" (p. 125). Adams and Rask (1968, pp. 941–42), among many others, share this view. The theory developed in this paper suggests that Ruttan's evaluation of such reforms is incorrect for those cases where the realities of the world do not violate the assumptions of the analysis. Instead, restricting the shares away from their optimum worsens economic efficiency and results in less output (on the average) and a lower level of input utilization.

Share restriction also does not improve the sharecropper's welfare in this analysis. While a restriction of the share may increase a sharecropper's expected income (as in examples 3 and 7), he is not made better off. His expected utility remains unchanged and the landlord's is decreased.

Therefore, legislation restricting share leasing cannot be justified on the grounds of improved productivity nor on the grounds of improving the sharecropper's welfare. In light of this, economists would be wise to reconsider their recommendations for future land reform policy.[16]

Models of share leasing have surprisingly broad applications. Forms of share leasing appear in a number of industries. In fishing, the crew's remuneration is based on a share of a trip's catch; in the legal profession, a lawyer's fee is often based on a share of the actual settlement; in the arts and entertainment fields, the artist and performer are frequently paid a royalty or a percentage of eventual realized revenue; and in retail sales, the salesperson is paid a commission or a share of the amount he or she sells.

Another area of interesting research is in the determination of the optimal terms for leasing public resources for their exploitation, e.g., timber lands and the oil and gas fields on the continental shelf. Although currently there is

[15] Allowing for these two items also would influence the optimal share and other leasing arrangements.

[16] Objectives other than improved efficiency and sharecropper welfare motivate many land reform programs. Whether restricting share leasing is justified to achieve these other objectives is beyond the scope of this paper. Most of the economics literature, however, has sought to justify share restrictions on the aforementioned efficiency and welfare grounds.

considerable research activity in this area, the problem has yet to be viewed as a problem of contractual choice, which as demonstrated above is the problem of share leasing.

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Resource Allocation and Risk: A Case Study of Smallholder Agriculture in Kenya

Jerome M. Wolgin

A model of economic behavior under conditions of uncertainty demonstrates that the traditional tests of economic efficiency in agriculture are generally misspecified. A data set from Kenya is used in testing a risk-aversion model; the results permit the following conclusions. Risk plays an important role in farmer decision making; farmers are efficient in their allocation of resources; and lack of credit availability is a major bottleneck in obtaining increased agricultural productivity for the regions studied in Kenya.

Key words: resource allocation, risk-aversion, Kenya, agricultural development.

Ever since Schultz suggested that peasant agriculture might, indeed, be efficient within the context of traditional technology and factor availability, a substantial amount of research has been undertaken to test this hypothesis. For if it is true that peasants act "rationally," then it follows that growth in agricultural productivity can be achieved by increasing factor availability and providing new technologies, and one might worry less about the more intractable problems of peasant values and attitudes (Nair).

Most of the literature on allocative efficiency in agriculture tests efficiency by determining whether the ratio of the mean marginal product of any input is equal to the input price. By such a measure, most studies have found peasant farmers to be reasonably efficient (Chemareddy, Hopper, Massell, Massell and Johnson, Sahota, Yotopoulos). Even Dillon and Anderson, in an article generally critical of the methodology employed in this area, concluded that using a probabilistic technique does not change this conclusion.

It is the purpose of this paper to show that such a test of allocative efficiency is misspecified if farmers are making their decisions in the presence of risk, and that small-scale farmers in Kenya, under conditions of uncertainty, behave as efficient, risk-averse entrepreneurs.

Agriculture in Kenya: The Setting

Because of its colonial heritage, Kenyan agriculture has historically been divided into two sectors—large-scale farms which were at one time called Scheduled Areas and from which Africans were prohibited and small-scale farms which were located in areas reserved solely for Africans. It is with this latter sector that this study is concerned.

One of the peculiarities of the farms within the small-scale sector is that they are in transition from subsistence to commercial farming. The basic crops are dairy products, produced by native grades of cattle, and maize, up to 90% of which is consumed on the farm and never enters the market economy. At the same time and in growing quantities, Kenyan farmers also produce coffee, tea, pyrethrum, and pineapples, all of which are cash crops. Thus, all small-scale farmers have to decide what combination of cash and subsistence crops to produce.

There are four primary factors in agricultural production—land, labor, capital, and purchased inputs. Of these, land, most labor, and some capital can be classified as traditional inputs owned by the farmer for which there are few well-defined markets; the rest

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are modern inputs and their availability depends on the market structure. The bulk of inputs into Kenyan agriculture fall in the former category (Wolgin, pp. 28–29). This implies that to some extent at least, the total quantity of agricultural inputs are limited, especially in the short run (crop-year). Certainly this is true of such traditional factors as capital (native grades of livestock, buildings, some tools) and land. With respect to labor, for which somewhere between 10% and 20% of all inputs are purchased off the farm, the situation is somewhat more flexible. However, the availability of hired labor is limited in peak seasons, since tribal prejudices tend to discourage in-migration of alien workers from areas which may be experiencing a period of slack (Ominde).

For other inputs markets are better articulated, although there are indications that some degree of monopoly prevails (Kenya 1966). The critical problem facing the ambitious farmer, i.e., the farmer who is attempting to expand production or undertake innovations and upgrading of his capital stock, is the scarcity of short-term and medium-term credit. Agricultural credit in Kenya, in accordance with the policy emphasis given to closure, resettlement, and land registration, has largely been directed toward long-term loans for land purchase. Loans of the medium term for capital equipment (especially improved breeds of dairy cattle) and for the crop year for current expenses such as fertilizer and wages have been given low priority (Kenya 1971, pp. 118–19). As will be shown, this limited capital availability has been an important factor in inhibiting agricultural growth.

Climate and ecological conditions in Kenya vary widely across space and time. The variation across space leads to the presence of a number of different ecological zones within which agricultural possibilities are similar. The sample which we will be using in this study has been divided into four strata on the basis of differing ecologies and cropping possibilities, following a scheme presented by Clayton. But it is the climatic variation across time which makes Kenyan agriculture so uncertain; at least one year in ten is a flood year and two years in ten have at least locally severe drought (Wolgin, p. 19). Thus maize, the basic subsistence crop, is in surplus some years and in deficit in other years. It is this uncertainty with respect to weather conditions that makes resource allocation decisions so difficult for Kenyan farmers, and makes inappropriate any study of the decision-making process which fails to take into account the question of risk.

A Neoclassical Model of Farmer Behavior in Kenya

It is not necessary to trace the development of the neoclassical model of behavior under conditions of uncertainty (Arrow), but its main features can be outlined briefly. The decision maker is assumed to have a utility function with one argument, income, which is itself a random variable with a known distribution. The decision rule, maximize expected utility, can be derived from a set of more basic assumptions relating to the transitivity and continuity of the utility function (Von Neumann and Morgenstern).

More concretely, consider the choices facing a farmer in Kenya. He possesses a set of resources (land, labor, capital, and purchased inputs) that can be used as inputs into a set of production processes, each of which has an uncertain outcome. Thus, this farmer, for whom risk is an important consideration, will maximize his expected utility rather than his expected income. By putting some plausible restrictions on both the utility function and the distribution of income, it becomes a rather simple problem analytically to arrive at that allocation of resources which is optimal.

Let us introduce the following notation:

Y = income in shillings,
Q_i = output in physical terms of crop i, $i = 1, 2$,
Q_i^e = expected output of crop i, $i = 1, 2$,
P_i = nonrandom component of the price of crop i, $i = 1, 2$,
F_i = family-owned inputs used in crop i, $i = 1, 2$,
F_t = total availability of family-owned inputs,
X_i = purchased inputs into crop i, in shillings, $i = 1, 2$,
S_i = marginal increment to risk of increased production of crop i, $i = 1, 2$,
u_i = random component of output, distributed with a mean of 1, and a finite variance, $i = 1, 2$,
v_i = random component of price, distributed with a mean of 1, and a finite variance, $i, = 1, 2$,

σ_y^2 = the variance of total income,
σ_{ij} = the covariance of income between crop i and crop j, $i, j = 1, 2$,
λ_k = Lagrangian multipliers, $k = 1, 2, 3$,
g, h = production functions for crops 1 and 2 respectively, and
g_i, h_i = first derivatives of the respective functions with respect to the ith argument, $i = 1, 2$.

Let the farmer's utility function U, which is continuous and twice differentiable, have the normal property of decreasing but positive marginal utility of income, i.e., let $U' > 0$ and $U'' < 0$. Given the function U, one only needs to know the distribution of Y, income, to have all the necessary information. Suppose, for example, that there are two crops whose physical outputs, Q_1 and Q_2, are given by the following production functions:

$$(1) \qquad Q_1 = g(F_1, X_1)\, u_1$$

and

$$(2) \qquad Q_2 = h(F_2, X_2)\, u_2.$$

If the prices of the two crops are given by P_1v_1 and P_2v_2 respectively, then net income, Y, is given by

$$(3) \quad Y = P_1 g(F_1, X_1)u_1v_1 + P_2 h(F_2, X_2)u_2v_2 - (X_1 + X_2)$$

with u_1, u_2, v_1, v_2 all positive. Outputs Q_1 and Q_2 are made up of stochastic and nonstochastic parts with the respective expected values given by

$$(4) \quad E(Q_1) = Q_1^e = g(F_1, X_1); \quad E(Q_2) = Q_2^e = h(F_2, X_2).$$

Similarly, the expected prices are

$$(5) \qquad E(P_1v_1) = P_1; \; E(P_2v_2) = P_2.$$

Let it be assumed that u_1 and u_2 are each independent of both v_1 and v_2; in other words, the random disturbance that affects price has no effect on output and inversely.[1] It will also be assumed that the joint distribution of the u_i's and v_i's can be approximated by a multivariate normal distribution.[2] Such an approximation not only provides a distribution, the moments of which are known, but it allows us to consider only the first two parameters of the distribution of Y and thus considerably simplifies the analytical presentation (Tobin 1958).

Since maximizing expected utility involves only the first two moments of the distribution of Y, the following relationship holds:

$$(6) \quad \max E(U(Y)) \sim \text{to } \max U^*(Y_e, \sigma_y^2) \quad \text{where } U^*_1 > 0 \text{ and } U^*_2 < 0.$$

It is also possible to simplify notation somewhat[3] by allowing:

$$(7) \quad \sigma_{ij} = \operatorname{cov} u_iu_j + \operatorname{cov} v_iv_j + \operatorname{cov} u_iu_j \operatorname{cov} v_iv_j.$$

Then,

$$(8) \quad \sigma_y^2 = P_1^2Q_1^{e2}\sigma_1^2 + P_2^2Q_2^{e2}\sigma_2^2 + 2P_1P_2Q_1^eQ_2^e\sigma_{12}.$$

It is also necessary to introduce a constraint limiting the total availability of family-owned inputs:

$$(9) \quad F_t = F_1 + F_2.$$

Then, the objective function (in the two-crop case) with all its constraints is given by

$$(10) \quad \begin{aligned} E(U(Y)) = {} & U^*((P_1Q_1^e + P_2Q_2^e - (X_1 + X_2)), (P_1^2Q_1^{e2}\sigma_1^2 \\ & + P_2^2Q_2^{e2}\sigma_2^2 \\ & + 2P_1P_2Q_1^eQ_2^e\sigma_{12})) \\ & + \lambda_1(Q_1^e - g(F_1,X_1)) \\ & + \lambda_2(Q_2^e - h(F_2,X_2)) \\ & + \lambda_3(F_t - F_1 - F_2). \end{aligned}$$

Maximizing equation (10) with respect to the nine choice variables ($Q_1^e, Q_2^e, F_1, F_2, X_1, X_2, \lambda_1, \lambda_2, \lambda_3$) and eliminating the λ_k's produces the following first-order conditions:

$$(11) \quad \begin{aligned} U^*_1P_1 + U^*_2(2P_1^2Q_1^e\sigma_1^2 + 2P_1P_2Q_2^e\sigma_{12}) - U^*_1/g_2 &= 0 \\ U^*_1P_2 + U^*_2(2P_2^2Q_2^e\sigma_2^2 + 2P_1P_2Q_1^e\sigma_{12}) - U^*_1/h_2 &= 0 \\ g_1h_2 - g_2h_1 &= 0 \\ Q_1^e - g(F_1,X_1) &= 0 \\ Q_2^e - h(F_2,X_2) &= 0 \\ F_t - F_1 - F_2 &= 0. \end{aligned}$$

As a background against which to discuss the implications of these first-order conditions,

[1] Only in the case of pyrethrum is this assumption questionable. For all other export crops Kenya is too small a producer for its output to affect world prices, and for locally marketed crops prices are set before the planting season.

[2] Since the range of u_i and v_i is limited to positive values and their mean is unity, it would seem reasonable to assume that these random variables are distributed log-normally (Feldstein). This presents very serious problems, as the joint distribution of a linear combination of log-normal variates (Y) is not, in general, known. Thus, we take refuge in the central limit theorem of probability theory, which states that any distribution with finite variance can be approximated by a normal distribution with the same moments.

[3] This is possible because of the assumption concerning the independence of the stochastic elements affecting price and output.

it is useful to review the conclusions of the theory of the firm in a world of perfect certainty. If firms act in such a way as to maximize profits, the following conditions must be met: (*a*) the marginal value product of any input equals its price, and therefore, (*b*) the ratio of the marginal physical products of any two inputs equals the price ratio of those inputs, and (*c*) the marginal value product of any input in any two uses are equal.

From the third equation of equation (11), it is clear that the second condition holds in our model. However, as will now be demonstrated, if the farmer is risk-averse, the first and third conditions for profit maximization will not in general hold in an uncertain world. Taking the ratio of the first two equations of equation (11) we get

$$(12)\quad \frac{(P_1g_2 - 1)}{(P_2h_2 - 1)} = \frac{(2P_1^2Q_1^e\sigma_1^2 + 2P_1P_2Q_2^e\sigma_{12})}{(2P_2^2Q_2^e\sigma_2^2 + 2P_1P_2Q_1^e\sigma_{12})}.$$

Define the following:

$$(13)\quad \begin{aligned} S_1 &= 2P_1^2Q_1^e\sigma_1^2 + 2P_1P_2Q_2^e\sigma_{12} \\ S_2 &= 2P_2^2Q_2^e\sigma_2^2 + 2P_1P_2Q_1^e\sigma_{12}. \end{aligned}$$

Then S_1 equals the partial derivative of σ_y^2 with respect to Q_1^e, and S_2 equals the partial derivative of σ_y^2 with respect to Q_2^e, i.e., S_1 and S_2 represent the marginal increments to risk of increased production of crops 1 and 2, respectively. If S_1 is greater than S_2, then crop 1 is riskier than crop 2. In any case,

$$(14)\quad P_1g_2 \gtreqless P_2h_2 \text{ as } S_1 \gtreqless S_2.$$

Equation (14) states that the marginal value product of any input into activity *i* is greater than, equal to, or less than the marginal value product of the same input into activity *j*, as the marginal increment to risk of increased production of commodity *i* is greater than, equal to, or less than the marginal increment to risk of increased production of commodity *j*. This result is analogous to that of portfolio-choice theory where investors who choose riskier assets expect higher returns (Markowitz, Tobin 1965).

A testable corollary of this proposition is that a ranking of crops by their marginal increments to risk (S_i) should be identical to a ranking of the marginal value products of any allocatable input across crops. This condition for economic efficiency, coupled with the profit-maximizing condition of the equality of the marginal physical products of any pair of inputs in each of two uses, makes it possible to test whether the behavior of the small-scale farmer in Kenya is consistent with the model propounded above.

Data and Estimation Techniques

Ideally, the model which is to be estimated requires a cross-section time series of microlevel data on inputs, outputs, and prices. With such a data set, information would be available to estimate not only cross-section production functions but also to measure directly the random disturbances affecting price and output as perceived by the farmer. Unfortunately, such a data set is unavailable at this time. What is available is a cross-section, farm-level series on inputs, outputs, and prices, and an aggregated, district level time series on marketed output and prices to the producer.

In broad outline, the basic set of data to be used in estimating agricultural production functions in Kenya is the Small Farm Sample Costs Survey (SFSCS) conducted in 1969–70 by the Statistics Division of the Ministry of Finance and Economic Planning of the Republic of Kenya. The SFSCS is a stratified random sample taken in the most important agricultural areas of Kenya, conducted by interviewers on a monthly basis. There are 1,500 farms in the sample, and information was recorded on 505 variables including such items as land devoted to each crop, labor inputs by crop, capital stock, nonfarm income, fertilizer inputs, wage rates, output prices at the farm gate, etc.

Once the data were edited (Wolgin, pp. 50–56), the sample was stratified into ecological zones. Ecological zone 3 includes some of the finest arable land in Kenya, suitable for tea, pyrethrum, maize, and dairy. Most of the land in this zone is located in the Western Highlands around Kisii and across the great Rift Valley. Zones 4 and 5 occur most often in the Central Highlands on the slopes of Mt. Kenya and the Abederes Range. The Kikuyu Grass zone (4), which is at a higher altitude and consequently gets more rain, is suitable for coffee and tea as well as the subsistence crops of maize and dairy. However, the uneven ter-

rain makes these Central Highlands areas unsuitable for large-scale farming. Zone 5 (star grass) is a coffee-growing region. Zone 6 is a conglomerate, including the low-lying areas of the Lake Victoria littoral and the coastal belt, an area of mostly subsistence farming with some coffee and cotton. These areas are among the poorest agricultural regions in Kenya. Cobb-Douglas production functions were then estimated for each crop for each ecological zone, using the instrumental variables technique to correct for any simultaneous equations bias (Marschak and Andrews, Nerlove, Walters).

In order to generate estimates for the u_i's and v_i's, the following procedure was followed. A Nerlovian adjustment-expectation model was used to calculate estimates of the nonstochastic components of price and output, using district-level time series on price to the producer and market output. The respective output and price equations[4] were

$$(15) \quad q_{it} = a_{0i} + a_{1i}t + a_{2i}p_{it-1} + u_{it}$$

and

$$(16) \quad p_{it} = b_{0i} + b_{1i}t + b_{2i}p_{it-1} + v_{it},$$

where q_{it} = the natural logarithm of marketed output of the ith crop at time t, t = time, p_{it} = price of the ith crop at time t, u_{it} = the random fluctuation of output of the ith crop, v_{it} = the random fluctuation of price of the ith crop, and a_{ki}, b_{ki} = parameters, k = 1, 2, 3.

Results

The price and mean marginal value product for each input for each crop by ecological zone are presented in table 1. The most salient feature of table 1 is the divergence between the marginal value product of any input and its price. This should not be surprising, as a careful analysis of equation set (11) indicates that the difference between the marginal value product of any input and its price depends on the marginal increment to risk of the given crop. In fact, of forty-seven marginal value products presented in table 1 (excluding family labor, for which no price is available), thirty-seven are greater than the price of the corresponding input. In the ten cases where the reverse is true, all but one occur in the production of the two subsistence crops—local maize and unimproved dairy.

One possible explanation for this conundrum is the fact that in evaluating marginal value products, the price to the producer for maize and milk has been used. There are, however, two prices for these subsistence crops—a consumer's price and a producer's price—and the wedge between them is substantial. Thus, a farmer who was risk-averse might overproduce subsistence crops in order to avoid the consequences of entering the market to purchase milk or maize meal (Massell and Johnson). Using consumer prices would reverse the inequalities for seven of these anomalous cases.

The second interesting feature of table 1 is that the ratio of marginal value product to price is much higher for marketed inputs than for family-owned inputs. The mean marginal value products of family labor are extremely low. This is not surprising for, although Kenya is not a labor surplus economy in the same sense that many countries in Southeast Asia may be, there are few alternative opportunities for employment off the farm, and the opportunity cost of family labor throughout a crop year may be very low.

This presents something of a paradox, since hired labor clearly has a much higher marginal product. While some of this differential between hired and family labor may be due to quality differences, the bulk probably can best be explained by the peculiar seasonality of input use in agriculture. Hired labor is used in seasons of great labor demand (planting and harvesting) and therefore has a much higher return.

The marginal value product of purchased inputs is in almost every case higher than its price. This is also true for capital, except in the case of unimproved breeds of dairy cattle.[5] In fact, the returns to capital goods are extremely high (often on the order of ten times the price of capital services), and this suggests that one of the key bottlenecks to increasing agricultural production among small farms in Kenya is lack of credit availability. This takes two forms—short-term credit for the purchase of inputs used during the crop year (fertilizers, hired labor, dips, feeds, etc.), and longer-term credit for the purchase of capital goods (particularly improved breeds of dairy cattle). As

[4] The assumptions underlying this specification of the output and price equations as well as the resultant estimations can be found in Wolgin, pp. 79, 116–20.

[5] The low marginal value product for unimproved grades of dairy cattle may reflect the importance of cattle as a consumption good in East African cultures.

Table 1. Mean Marginal Value Products and Prices for Agricultural Inputs in Kenya, 1969–70 (Shillings per Unit Input)

Zone 3 (balanced mixed farming):

	Mean Marginal Value Product by Crop					
Input	Local Maize	Hybrid Maize	Pyreth-rum	Improved Dairy	Unimproved Dairy	Price
Acre of land	157.95	218.73	63.59	93.10	77.27	41.20
Man-day of family labor	0.85	0.56	4.95	0.59	0.27	—
Man-day of hired labor	7.03	—	15.48	12.18	—	3.50
Shilling of purchased input	1.44	3.27	—	3.45	0.28	1.00
Shilling of capital	1.23	1.89	—	0.33	0.08	0.12

Zone 4 (kikuyu grass):

	Mean Marginal Value Product by Crop				
Input	Local Dairy	Coffee	Tea	Improved Dairy	Price
Acre of land	13.95	101.50	363.12	101.61	28.24
Man-day of family labor	0.70	2.13	9.86	1.84	—
Man-day of hired labor	1.87	1.47	—	—	2.46
Shilling of purchased input	7.06	4.30	—	4.22	1.00
Shilling of capital	1.13	—	—	0.60	0.12

Zone 5 (star grass):

	Mean Marginal Value Product by Crop					
Input	Local Maize	Hybrid Maize	Cotton	Coffee	Unimproved Dairy	Price
Acre of land	39.28	86.09	92.38	110.78	33.64	39.84
Man-day of family labor	0.66	1.04	0.43	0.84	0.26	—
Man-day of hired labor	0.20	—	—	4.11	—	1.58
Shilling of purchased inputs	1.07	2.78	—	1.37	0.88	1.00
Shilling of capital	0.37	2.54	—	—	0.09	0.12

Zone 6 (grass plains, savannah, coastal belt):

	Mean Marginal Value Product by Crop		
Input	Local Maize	Unimproved Dairy	Price
Acre of land	19.25	30.86	26.64
Man-day of family labor	0.33	0.15	—
Man-day of hired labor	3.86	—	3.11
Shilling of purchased input	2.57	1.05	1.00
Shilling of capital	0.60	0.48	0.12

Source: Raw data were obtained from the Statistics Division of the Ministry of Finance and Economic Planning of the Republic of Kenya.
Notes: One Kenya shilling equals 0.14¢, U.S. For land and capital, an estimate has been made of the value of current services, using an 8% interest rate. For crops, the capital input is measured as the value of tools, while for dairy products, the capital input is the value of the respective livestock. Where no number is entered in the table, there were too few observations for reliable estimates.

mentioned above, credit in Kenya has been provided mainly for the purchasing of land which, while it has important redistributional effects, has a negligible impact on increasing agricultural incomes.

The proposition was advanced that if farmers are risk-averse, the marginal value products of any inputs across crops will not be equal but will depend on the marginal increment to risk of each crop. This implies that the ranking of the marginal value products across crops will be identical for all inputs. While the data in table 2 are not completely appropriate for testing this proposition, they should pro-

Table 2. Rankings of Marginal Value Products by Crop, by Ecological Zone

Zone 3 (balanced mixed farming):

Input	Crop				
	Local Maize	Hybrid Maize	Pyrethrum	Improved Dairy	Unimproved Dairy
Land	2	1	5	3	4
Family labor	2	4	1	3	5
Hired labor	4	—	1	2	—
Purchased inputs	4	2	—	3	5
Capital	3	2	—	4	5
Coefficient of variation	0.3	0.2	0.8	0.2	0.1

Zone 4 (kikuyu grass):

Input	Crop			
	Local Maize	Coffee	Tea	Improved Dairy
Land	4	2.5	1	2.5
Family labor	4	2	1	3
Hired labor	2	3	—	—
Purchased inputs	2	3	—	4
Capital	2	—	—	4
Coefficient of variation	0.4	0.2	0	0.2

Zone 5 (star grass):

Input	Crop				
	Local Maize	Hybrid Maize	Cotton	Coffee	Unimproved Dairy
Land	4	3	2	1	5
Family labor	3	1	4	2	5
Hired labor	4	—	—	2	—
Purchased inputs	4	1	—	2	5
Capital	4	1	—	—	5
Coefficient of variation	0.1	0.5	0.3	0.2	0

Zone 6 (grass plains, savannah, coastal belt):

Input	Crop	
	Local Maize	Unimproved Dairy
Land	2	1
Family labor	1	2
Hired labor	1	—
Purchased inputs	1	2
Capital	1	2
Coefficient of variation	0.3	0.2

vide some indication of whether these expectations are likely to be fulfilled,[6] that is, one would expect the ranking of coffee marginal value products to be the same for labor as it is for land. These rankings are presented in table 2.

While the results presented in table 2 are not completely satisfactory, they are consistent enough to indicate the ordering of crops on the basis of the marginal value product. In only three of the sixteen cases was the coefficient of variation greater than 0.3, and in only one case was it greater than 0.5. The failure of the production function results to provide a consistent ranking across all inputs can be ascribed to the various constraints which limit the farmer's ability to freely allocate resources in the short run.

It was argued above that the only profit-maximizing test of economic efficiency that holds, once uncertainty has been introduced, is that the ratio of the marginal products of any two factors into a given crop i should be equal to the ratio of the marginal products of those same two factors into any other crop j. In order to test this proposition, the sample was divided into eighteen subsamples representing different cropping patterns. For example, all farms in zone 3 producing only maize, coffee, and improved dairy were separated into a subsample and tested for the equality of any pair of ratios of marginal products. In particular, the factors chosen were those over which the farmer had some freedom of allocation in the short run—land/family labor for those crops which are produced annually and family labor/hired labor and family labor/purchased inputs where otherwise appropriate.

These ratios were then tested by means of paired t-tests to determine if the sample means of any pair of ratios were significantly different from each other. The results are presented in table 3. Although interpretation of these results involves some degree of subjectivity, it seems fair to state that farmers in Kenya are relatively efficient in their allocation of resources among crops.

It has also been argued in equation (14) that the higher the marginal value product, the higher the marginal increment to risk and conversely. To test this proposition, it is necessary to examine the same subsamples that were used in testing allocative efficiency. There are eighteen of these subsamples of identical cropping patterns; of these nine groups grow only two crops, another six grow three crops, and three grow four different crops. Altogether this means that there are forty-five possible pairings of crops; of these, thirty-nine exhibited behavior consonant with the model, i.e., the crop with the higher marginal value product also had the higher marginal increment to risk. These results are presented in table 4.

Thus it is clear that risk aversion plays a very important role in farmer behavior; farmers are willing to grow high risk crops only if they get a higher payoff in expected return.[7] Moreover, risk aversion may help explain why farmers are interested in multicropping (assuming no joint production). By producing a mutual fund of crops, they can get the same range of expected return at lower levels of risk, as they would if they grew only one crop at a much higher risk level (Tobin 1965).

By fixing output prices, the government of Kenya is already acting in such a way as to minimize risk. However, if the random variables affecting price and output are correlated negatively, such a policy may in fact be coun-

[6] The appropriate samples for testing this proposition are farms with identical cropping patterns. This is because risk is a property of a portfolio rather than of a particular crop. Accordingly, this proposition will be tested more rigorously below.

[7] It should be noted that several of the assumptions underlying this paper, particularly the specification of Cobb-Douglas production functions, are somewhat restrictive. Accordingly, the conclusions may not be as robust as indicated.

Table 3. Results of the Profit-Maximizing Test of Economic Efficiency

Input Pair	Number of Cases Where Ratio of Marginal Products of Given Input Pair Are: Equal across Two Crops	Unequal across Two Crops
Land/family labor	25	4
Family labor/purchased inputs	13	3
Family labor/hired labor	6	0
Total	44	7
Percentage of total	86.3	13.7

Table 4. Results of Test of Risk Aversion and Economic Efficiency

Number of Crops Grown in Subsample	Number of Cases for Any Two Crops: Marginal Increment to Risk Ranked Identically with MVP	Marginal Increment to Risk Not Ranked Identically with MVP
2	8	1
3	16	2
4	15	3
Total	39	6
Percentage of total	86.7	13.3

terproductive. Most importantly, if farmers are risk-averse and are unable to produce optimally because of credit limitations, a policy of expanded farm credit could alleviate both problems.

It has been argued by many writers that absolute and relative risk aversion decline with increased income (Arrow). If farmers were able to obtain credit not only for purchase of modern inputs but also to insure survival in the face of adverse weather conditions, they would be more willing to take risks in order to obtain higher expected return. Moreover, since climate varies so widely throughout Kenya, a government insurance program would lower risk for the entire country by creating a mutual fund of different geographical areas. This, then, might be one of those rare opportunities for raising agricultural output without cost.

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Imperfect Competition in a Vertical Market Network: The Case of Rubber in Thailand

Laurence D. Stifel

The efficiency of the sheet rubber marketing system in Thailand is analyzed in the framework of the structure-conduct-performance model from the field of industrial organization. Market performance is evaluated by the degree of monopsony profits and progressiveness. Examination of the multiple relationships at the three principal levels of the vertical network indicates that the system does not fit pure models of microeconomic theory. Comprehensive analysis leads to different conclusions than the more traditional, partial analysis. Diagnosing the structural and behavioral determinants of performance also assists in identifying policy measures to improve marketing efficiency.

Key words: marketing efficiency, structure-conduct-performance model, rubber, Thailand.

Thai rubber marketing will be analyzed in a framework which recognizes the multiple dimensions of the relationships constituting a market system. Studies of marketing in developing countries have frequently focused on segments of a system and reached polar conclusions, either atomistic competition or monopolistic inefficiency, with contradictory policy implications. Systematic analysis of the critical elements of the rubber market is facilitated by application of the familiar model from the field of industrial organization which traces a causal sequence from market structure to market conduct to market performance.

Although Thailand is the world's third largest natural rubber producer, the industry is backward compared to that in other producing countries. In the absence of government promotion or Western investment, the industry developed by the multiplication of small family holdings, many of which now are old with declining yields and abandoned except during periods of high prices. The Thai government initiated programs in the 1960s to introduce the technical advances made in other producing countries, especially replanting with high yielding rubber varieties, but resources were inadequate to reach more than a small share of the peasant producers in the southern region of Thailand where rubber production is concentrated.

The competitive model will be used to set norms against which empirically observed performance in the rubber industry can be evaluated (Baldwin, Wharton). If the conditions of the competitive model are satisfied, the assumption is that prices and quantities are at optimal levels in a partial equilibrium, static welfare sense, and economic efficiency in this narrow sense should be realized. The logic of this assumption will be briefly reviewed in a model of the vertical market network before proceeding to the analysis of market structure, conduct, and performance in the industry.

The market demand curves for rubber sheets within Thailand are purely derived demand curves, except for those in the final markets which consist of the sum of the demands of the industrial consumers in Thailand and the foreign buyers who constitute the "world rubber market." Since Thailand produces only about 4% of world rubber, natural plus synthetic, it is reasonable to assume that it is a "price taker" facing a nearly horizontal demand curve.

In figure 1, D_E represents world rubber demand as it appears to the Thai exporters. Their total demand curve, or the demand curve at the middle level market where export-

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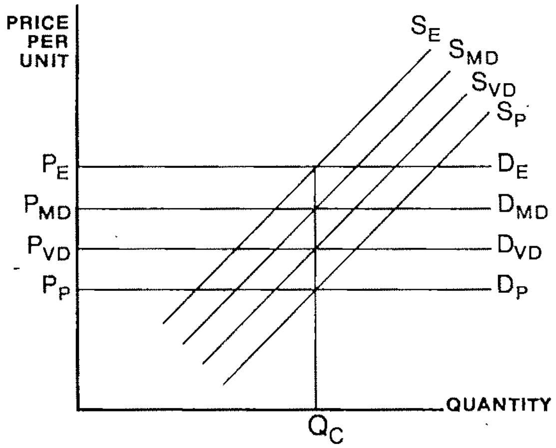

Figure 1. Vertical rubber market network: the competitive model

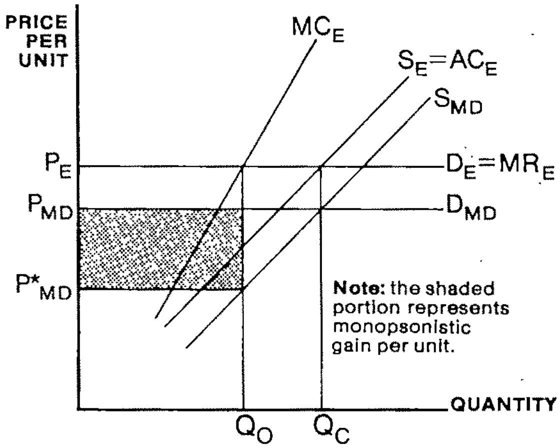

Figure 2. The effect of monopsony rubber buying at the export level

In the subscript, P represents producer level, VD represents village dealer, MD middle dealer, and E exporter.

ers buy in order to sell on the world market, is D_{MD}. The difference between the two curves is equal to the actual cost of the marketing and processing services provided by the exporters, plus the opportunity cost of their capital and labor. At the next level of the vertical network, D_{VD} represents the demand curve of the middle level dealers who purchase rubber at the village level and resell to the exporters. The vertical distance between the respective curves in each case represents the economic costs of the marketing function. The demand curve of the village dealers for unsmoked sheet at the producers' level is represented by D_P. The equilibrium price is established at P_P by the intersection of this curve with the producers' supply curve, S_P. The supply curves at higher levels are derived curves, equal to the supply price at the preceding level plus the same economic costs of the marketing function. The quantity supplied and the prices to the producers are thus determined competitively by their supply schedules and the derived demand curve. Shifts of the world market demand schedule would be the source of price changes, and shifts in the Thai supply schedule, S_P, would cause changes in the equilibrium volume of production.

Departures from the competitively determined series of prices or equilibrium volume would evidence imperfections in the market structure. The potential inefficiency exists on the buying side, the possibility of monopsony, rather than in monopolistic practices on the selling side. Since the demand schedules at all levels are derived demands originating in the world market, potential monopolists at any level could not raise their selling prices by reducing sales. But when a firm or group of firms in collusion is a sufficiently large buyer of an input to have an effect on the buying price, it can maximize profit at a lower price and volume of purchases than the competitive norm.

The effect of buying rubber monopsonistically but selling it in a competitive market is shown in figure 2 which depicts the upper portion of the figure 1 network. Assume collusion exists at the exporter level where departures from the competitive structure will adversely affect the entire vertical network. The exporter would be facing a rubber supply schedule, S_{MD}, his average cost of purchasing rubber from the middle dealers. The exporters' total unit cost is S_{MD} plus the economic costs of providing the marketing function; this totals to S_E, the exporters' total supply curve shown in figure 1. If the few exporters are able to agree to standardize their buying prices for smoked sheets from the middle dealers, they will be able to realize monopsony gains. Prior to the agreement, no single firm could purchase rubber below P_{MD}, the competitive market price. By recognizing their mutual dependence, the exporters can uniformly reduce their prices and still obtain rubber, although a smaller quantity, depending upon the elasticity of supply at that point. Reduced volume causes the exporters' costs to fall but their marginal

costs decline faster, as indicated by the marginal cost curve, MC_E, which shows the usual relationship to the average cost curve. To maximize profit the group would reduce buying prices and quantity of rubber purchased to the point where marginal costs, MC_E, equal the marginal revenues, MR_E, from selling in the world market. At this point, D_E (world demand) = MR_E (the exporters' marginal revenue) = P_E (world market price). Rubber purchases would be reduced from Q_c to Q_0 and price would fall at the middle dealer level from P_{MD} to P^*_{MD}. The exporters would receive an excess profit equal to the difference between P_{MD} and P^*_{MD} at the reduced quantity purchased. In this case, the remaining middlemen would remain competitive and simply transmit the lower prices to the producers. However, if there were additional, independent monopsony power at other levels, the distortions from the competitive norm would cumulate and further reduce the welfare of the village producers.

Overview of the Rubber-Marketing System

Rubber flows up through the marketing system in two streams: approximately 80% is sheet rubber which is smoked and baled for export and the remainder is scrap which is sold to large remilling factories for the production of crepe. This study focuses primarily on the sheet market which is divided vertically into the market for unsmoked and the market for smoked sheets. One can accurately assess the sheet's quality and the weight of the dry rubber only after smoking. The sheets are wet and opaque in unsmoked form, and grading is based upon visual inspection for characteristics such as cleanliness, evenness, and freedom from defects. In the market for unsmoked sheets, the grade can be only roughly estimated and the problem is acerbated by the low quality and high variability of Thai production.

The large export firms, with facilities for smoking, grading, and exporting, form the market for smoked sheet at the top of the vertical chain. They receive unsmoked sheet from the middle dealers, but they purchase smoked sheet, the final settlement depending on the weight and grade distribution after smoking; they also purchase sheet from the larger plantations, some of which operate their own smokehouses.

Middle dealers, at the second level, purchase unsmoked sheet from village dealers, mobile collectors, and plantation owners who do not have large enough volumes to sell directly to the exporters. They sell smoked sheets to the exporters who require a minimum transaction size of roughly a ton because of the costs of separate handling in the smokehouse. They usually have licensed shops dealing primarily in rubber in the district or provincial markets. The village dealers have shops where they purchase directly from planters and mobile collectors, and they may also provide a mobile collection service themselves; they often retail a variety of consumption goods and rubber trading may be a subsidiary activity. The mobile collectors at the lowest level are unlicensed traders who travel by bicycle or motorcycle to purchase unsmoked sheets at the remotest holdings.

Although the statistics on rubber are the weakest on any major part of the Thai agricultural economy, pieces of the system can be approximated from different sources and fitted together in a pattern which is plausible and consistent. Rubber is turned over about 3.2 times in the marketing system: starting with the original sale by the farmers, 1.2 times at intermediate levels, and concluding with the exporters' final sales. Quantification of these flows facilitates the rough estimation of the number of traders at each level shown in table 1.

Market Structure

Market structure refers to the characteristics of the market which affect the traders' behavior and, in turn, their performance. Three elements of the rubber market structure will be analyzed: concentration ratios, supply elasticities, and the conditions of market entry.

Degree of Concentration by Market Level

At the exporter level, there is a high degree of market concentration by a small set of Chinese rubber firms from Singapore and Malaya that established Thai companies in Southern Thailand after World War II (Thai Ministry of Agriculture, Rubber Division). In 1949, there were thirty-five licensed exporters

Table 1. Selected Data on Thai Rubber Traders by Market Level, 1972

	Rubber Sales (tons)			
Market Level	Sales as a % of Production	Total Monthly Volume	Average Monthly Volume per Seller	Estimated Number of Sellers
Exporters	96%	27,680	1,538	18
Middle dealers	74%	21,337	48	441
Village dealers	44%	12,687	2	6,343
Mobile collectors	9%	2,595	0.5	5,190
Plantations	100%	28,833	0.1	300,000

Sources: Data on exporters are from the Thailand Ministry of Agriculture, Rubber Division, on middle dealers from Stifel (1973b), and on village dealers and mobile collectors from Chamnian (pp. 4–6). For detailed references to Thai language sources, see Stifel (1973b, p. 6).

sharing in the postwar boom, but by 1950 the market was stabilized with a few firms clearly established as paramount. The high concentration and stability over this period are shown in table 2 in which the exporters are identified by letter. With the exception of company D which is Sino-Thai, the primary firms are all affiliated with Singapore rubber interests. Their directors have frequent associations through their trade organization and the social activities of their Chinese clan group. The exporters' control of the market is strengthened by their extensive backward integration into processing facilities; the largest own most of the capacity for smoking sheets and producing crepes.

Concentration ratios assume their significance in relation to effective market areas. The rubber-producing area is segmented into natural markets, each with an exporting center at its hub and a configuration depending on the surrounding topography and transportation facilities. Except for those in the penumbra of these markets, the middle dealers seldom transport their rubber to sell outside their natural market. The degree of concentration in the major market areas is significantly higher than the national average presented above. The major exporters have sought horizontal coverage through multiple offices in order to sustain or increase their market shares. The same large firms tend to dominate most major markets although smaller local firms have established positions in some. The few buyers in each market, their social homogeneity and control of the essential processing capacity appear to represent the classic structural conditions for monopsonistic power.

Since market concentration ratios at the levels of the middle and village dealers are not available, conclusions must be based upon qualitative assessment of the evidence. The number of middle dealers fell 40% from 1959 to 1972 while production grew at an annual rate of 6.5%. The decline in middle dealers can be partially explained by the broadening of natural market areas caused by the expansion of the road system in the rubber-producing areas. While the changing spatial dimensions of the local market areas obscure the process of changing concentration, it is possible to calculate that in 1972 there was an average of 8.6 middle dealers per district

Table 2. Data on the Structure of the Thai Rubber Market at the Exporter Level

	1955	1960	1965	1970	1972
Top Four Exporters					
Firms	ABDM	ABDH	ABDH	ABCD	ABCD
% of total exports	68	55	74	75	78
Total number of exporters	21	25	16	20	18
Gini coefficient: all exporters[a]	0.60	0.58	0.62	0.68	0.69

Source: Thailand Ministry of Agriculture, Rubber Division.

[a] The Gini coefficient is a summary index of concentration which measures the ratio of the area between a Lorenz curve and the diagonal curve showing perfect equality to the entire area below the diagonal curve. A coefficient of zero indicates perfect equality of firm shares and a coefficient of 1.0 total inequality (Singer, pp. 144–49).

where they are customarily clustered together in a single market place. Economic theory provides little guidance in evaluating whether this is adequate to assure competition, but it is reasonable to assume that the degree of competition, judging by the number of middle dealers per market, varies positively with the size of the market. A dozen or more dealers concentrated in the larger markets, with shops of similar size and dealing in a relatively homogeneous product, would suggest a structure at least consistent with competitive behavior.

Casual observation suggests that only a handful of village traders operates in each small local market. Mobile collectors with bicycles cannot travel far; according to Chamnian, they purchased 90% of their rubber within a five-kilometer radius (p. 10). The village trader's market is often rigidly defined by the cost of transporting goods and sheets over the surrounding network of unpaved roads, where trucks often give way to elephants in the rainy season. A small village market off the national highway system might typically have one to four shops buying rubber and several mobile collectors who might be buying agents of the shops. Within each geographically segmented area, the market concentration would thus probably be rather high although no precise estimates are possible.

The Effect of Supply Inelasticities

The producers' elasticity of supply with respect to price affects the potential for monopsony gains. In the extreme case, as the elasticity approaches zero, the only limit to the power of the trader-monopsonists to reduce prices would be the threat of new firms entering the market. Econometric studies in producing countries indicate that the short-run supply schedule of rubber is price inelastic, especially under conditions of peasant production as in Thailand. During the period of the Thai industry's expansion before World War II, rubber planters responded to price changes by changing the number of tapping days or the daily number of trees tapped because labor could still be shifted to and from traditional occupations, especially paddy cultivation. The expansion of rubber planting and increasing specialization for the cash market reduced the villagers' flexibility. The elasticity of production with respect to rubber prices fell from 0.77 during the former period to 0.15 after the war.[1] Rubber transformed southern Thailand into a market-oriented, cash economy but at the same time it locked the villagers into a long-term commitment to a single crop without obviously viable alternatives.

Barriers to New Competition in the Market

The final element of structure, the conditions of entry into the market, determines the extent to which established dealers can use potential market power without inducing new competition.

The large exporters have advantages over new entrants in the market because of their recognized position in the world rubber trade. Foreign buyers trust them to honor claims for overclassification and to fulfill forward contracts, even in the face of steep losses caused by a rising market. More importantly, there are economies of scale in securing knowledge of the world market. Through their Singapore associates and foreign agents, the large exporters participate in a sophisticated and expensive network of market information. While skill in selling improves with knowledge (size) and experience, there are no offsetting diseconomies of scale in the buying process. The size of firms in the unsmoked sheet market is limited by the fact that the requirement for entrepreneurial time per unit is a function of product uncertainty. Since the exporters buy graded smoked sheet, purchasing can be a routine process delegated to branch managers and expanded to provide the supply to fulfill commitments.

Large capitalization is required to realize the benefits of scale enjoyed by the top exporting companies. The size of the exporters' required investment in inventory restricts potential entry to wealthy businessmen with resources and prime credit. The exporters pay the middle dealer levels an advance at the time of delivery and must finance the stocks through the period of smoking, grading, baling, and shipping to the foreign buyer. Each of the top four exporters held stocks during 1968–72 averaging almost 57 million Baht, a sum beyond the financial capacity of typical small exporters or large middle dealers (Thai

[1] Stifel's use of exports plus estimated domestic consumption as a proxy for production will exaggerate inelasticity if there are monopsonistic departures from competition as in fig. 2 (Stifel 1973a, p. 122).

Ministry of Agriculture, Rubber Division). These large firms enjoy prime credit rates in Bangkok and in the international capital markets. Calculations of profit in the following section on market performance indicate that the top firms' advantage in the capital market gives them a profit margin as a percentage of sales twice as high as the smaller exporters; traders borrowing in the unorganized capital markets could not compete at this market level.

Barriers to the entry of new competition at lower levels of the market are weaker and more difficult to identify. There are only limited economies of scale in the unsmoked sheet market, since average costs rise at volumes beyond the point at which the trader's personal attention is possible. The average capital requirements are relatively small, although dealers with preferred access to credit vis-à-vis potential competition realize similar cost advantages. A large middle dealer's average interest cost per unit of sales is roughly half a smaller dealer's interest cost or one quarter that of a village dealer who might hope to expand upward to a higher market level (Rozental, p. 249, Stifel 1973b, p. 15).

In conclusion, the three elements of market structure are summarized in table 3.

Market Conduct

Market conduct refers to pricing policies and practices designed to stabilize market relationships and reduce the significance of price competition. Market conduct in this industry has accommodated the poor and variable quality of production rather than encouraged improvement and standardization, with the result that Thai rubber is currently produced and processed essentially the same as it has been for many decades.

Daily Chinese radio broadcasts transmit rubber prices from Singapore into Thailand and there are many permutations as they filter down through the vertical market network. Price quotations in the smoked sheet rubber market are openly announced and unambiguous. Easy telephone communication permits the rapid horizontal spread of information, and prices move together with a high degree of uniformity within markets and between different geographic markets. Exporters avoid price competition to increase their market shares but they may raise prices temporarily to increase short-run supply to meet current commitments. The structure of the market and the similar pricing practices of the major firms thus operate to maintain relatively parallel wholesale price movements throughout the country, with persistent differences arising from differentials in costs of transportation and smoking.

Price quotations in the unsmoked sheet market, on the contrary, are ambiguous because of the unknown moisture content and grade classification. Middle traders normally do not attempt to grade sheets by quality; they typically glance at the pile of sheets, sort out the worst, and offer a price per kilogram for the mixed bundle remaining. They are generally familiar with the suppliers and the quality of the rubber in their buying areas; from past experience they can make spot decisions for any particular batch. Traders in one market will tend to offer approximately similar prices on a given day to most suppliers unless their rubber is well above or below the average. The practice of average pricing deters quality improvement because the seller is able to increase his return to the extent he can include dirty and wet rubber sheets in the mixed bundle; the seller of higher quality sheets conversely will receive a lower price for the dry rubber content if his quantity is small and outside of the buyer's normal experience. Uncertainty concerning the rubber's quality, therefore, encourages mixed grade pricing, drives down the price of better quality sheets, and enhances the value of stable trading relationships.

Table 3. Elements of Market Structure: Thai Rubber, 1972

	Market concentration	Supply inelasticity	Barriers to entry
Exporters	high	high	high
Middle dealers	moderate	high	low to moderate
Village dealers	high	high	low to moderate

Source: Stifel (1973b).

The hypothesis of the competitive model is that the unsmoked sheet market will transmit prices efficiently through the vertical chain to the level of the village producers. With the exception of a special case discussed later with reference to economic performance, analysis of the few unsmoked sheet price series which are available indicates no significant correlation between prices horizontally in different village markets or between prices vertically from producers to higher levels. Unfortunately the ambiguous qualitative characteristics of unsmoked sheet serve to obfuscate the significance of the analysis; the quantitative data fail to support the competitive hypothesis but they are too unreliable to serve as a basis for its rejection.

Pricing practices in both the smoked and the unsmoked sheet markets are stabilized by a relationship of trust between buyers and sellers. The buyers benefit from securing regular supply sources, thus reducing the danger of self-destructive price competition. The sellers must trust the buyer's grading and weighing, for carrying the heavy sheets to bargain with another trader is extremely troublesome. Trust evolves over time out of a continuing relationship in which each party perceives mutual self-interest. The broad stream of rubber flowing up through the market system thus consists of vertical strands, each representing a relatively stable linkage between small numbers of buyers and sellers. On the average, the middle dealer normally sells to only 1.6 different exporters, the village dealer to 2.0 middle dealers (Stifel 1973b, p. 19). Middle and village traders estimate that two-thirds of their supply comes from steady customers whom they know personally and whose rubber they have handled for many years.

Traders assist their steady suppliers with credit for working capital and for covering inventory losses caused by price fluctuations. At the highest level, the exporters' advances to the middle dealers finance their rubber through the smoking process. They will also give unsecured and interest-free loans to cover suppliers' inventory losses if they consider their supply potential to warrant the risk. Traders in the unsmoked sheet market similarly provide credit in order to sustain and strengthen the relationship with steady suppliers and to expand their business by obligating new ones. Although the reciprocities are not finely calculated, a bond is established. The period of the loan is not fixed, but it is understood that the debtor will deliver rubber to the creditor, partly in repayment of the loan. The two parties are frequently of different races or at least different Chinese dialect groups, and their relationships are always under stress because of the continuing need to confirm mutual self-interest. As firms rise or fall, market shares slowly change; buyers and sellers establish new relationships, but the strength of the bond is difficult to measure because of the traders' reluctance to reveal its quantitative dimensions and because social experiments to measure it are not feasible.

Market Performance

In this final section market performance is evaluated in relationship to its structural conditions and conduct with regard to pricing and product policies. The criteria of market performance are static efficiency in the use of resources, the absence of monopsony profits, and dynamic progressiveness in the improvement of the system so as to maximize the general welfare of the society.

The margins between different levels have been compared, to the extent possible, to total economic costs to determine whether excess profits exist. According to the model in figure 1, prices are passed down from level to level in the marketing chain and margins at each level should be independent of prices except to the extent they affect the cost of working capital. The coefficient of the independent variable in a regression of prices at one level on prices at a higher level should tend toward unity to be consistent with the competitive model.[2] The analysis starts with the smoked sheet market where reasonably reliable domestic price data have been available since 1969.

The marketing margins in the smoked sheet market are consistent with two hypotheses: (*a*) average unit profit rates on ordinary sheet trading are low and excess profits, if they exist, must be derived largely from related operations such as crepe production or price speculation; (*b*) the large exporters have substantially higher profits than the small exporters but they find it advantageous to tolerate the operations of smaller firms at the fringes of the market. The net marketing margin after

[2] Since a coefficient of 1 could also result from perfect collusion in price fixing, evidence on structure and conduct are necessary to interpret its significance. Price data in this section are from Thailand Ministry of Agriculture, Rubber Research Centre.

deducting estimated costs, including interest, at mean prices for 1969–72 was only 0.2% of sales for the large exporter borrowing at 8% interest and 0.1% for the small exporter borrowing at 12%. The profit before interest charges was equal to a 13.4% return on working capital which is not considered high in Thailand (Stifel 1973b, pp. 21–22).

The four largest exporters, with an average size twelve times larger than the bottom fourteen firms, realize the economies of scale previously noted in addition to the lower interest costs. According to small exporters, the top four do not use their power to increase their market shares because the survival of the small firms functions to shield them from charges of monopoly and to set a floor for profits.

Thai smoked sheet prices are closely related to Singapore prices, the Singapore-Thai exchange rate, and freight costs, as demonstrated in the following regression, where Y = Thai rubber price, X_1 = Singapore rubber price, X_2 = Singapore-Thai exchange rate, X_3 = index of freight rates (rubber prices are spot quotations for RSS, Ribbed Smoked Sheets, grade 3); observations are monthly for the period 1969–72; t-values are in parentheses; and the Durbin-Watson statistic is 1.75:[3]

$$Y = \underset{}{1.499} + \underset{(79.95)}{0.948X_1} - \underset{(-4.56)}{0.280X_2} + \underset{(3.06)}{0.002X_3} \quad \bar{R}^2 = 0.995.$$

The range of net profits before interest charges was calculated from the regression equation at the median values of X_1 in the upper and lower thirds of all observations; the return on working capital would have varied from 3% to 22% during this period. Since the competitive assumption is that the return on investment should be constant, this evidence is inconsistent with the competitive model. Although returns at the lower level are below opportunity costs of capital, firms have survived during periods of low prices. Since the Thai prices and marketing cost estimates are unverified reports by the exporters, it is possible that they cause the entire range of profits to be underestimated. While the analysis of margins at mean prices suggests low profits, the contradictory evidence of the time series is strengthened by the structural conditions which favor monopsony in this market. The value of the Singapore dollar was appreciating relative to the Thai baht during this period and the large middle dealers complained that the exporters were not passing on their exchange rate gains to the Thai market.

The recent formation of group marketing organizations (GMOs) has yielded the first accurate price series for the unsmoked sheet market and provided insight into the dynamics of the marketing system. The total margin in the unsmoked sheet market is the difference between the exporters' buying prices (less smoking charges and adjustment for weight loss) and the producers' selling prices; it may be shared among one to three trading levels. A GMO is a group of smallholders whose members process their rubber on private equipment but assemble the sheets for bulk sales directly to middle dealers. Government officers teach them how to calculate reasonable prices from the local radio quotations of RSS prices and how to bargain on the basis of volume and quality. Bulk sales require uniform quality and the extension officers have demonstrated that the villagers can produce high quality sheets on their old equipment simply through increased care and the use of inexpensive wire strainers.

The GMOs represent a structural change which has altered pricing conduct and improved the performance of the marketing system. At the time of each sale the GMO leader records the price on the bulk sale and the average price prevailing in the market. The difference measures the gain which can be attributed to improvements in quality of the sheets and marketing efficiency, as well as the effect of collective bargaining in reducing traders' monopsonistic profits. Extension officers estimated that the GMOs have produced dryer sheets, with average grades of RSS 1–2, compared to RSS 3–4 in the past. If this is accurate, quality improvements explain most of the price gain—79% to 100%, depending on the estimated moisture content. Relatively little or no surplus remains to be identified as monopsony profits.

The sales records of the GMOs provide the most reliable time series of marketing margins for the wet sheet market. Regression analysis indicates that the GMO prices closely follow

[3] The coefficient of the independent variables are significant at the 0.01 level and there was no statistical evidence of multicollinearity. The Thai price is identified as the dependent variable for the reasons stated earlier; the rubber trade considers Singapore to represent the world market price, P_E in fig. 1, and Thai exporters consciously base their local buying prices on Singapore quotations. The freight index is the weighted average of quotations of ships of all flags on important world routes (UN, FAO).

the RSS prices in the nearest market but that margins vary with the level of prices. Margins have been calculated at the extreme prices observed and standard cost estimates have been deducted to suggest the range in profits shown in table 4. Profits ranging up to ฿. 13 per kilogram hardly cover economic costs, unless traders augment them through related activities such as buying scrap or transporting rubber. The evidence from other studies and surveys is consistent with these profit estimates for areas where the local market structure discourages monopsony. The GMOs demonstrate that, by standardizing and improving quality, calculating prices, and bargaining with the traders, the producers can break through the barrier of traditional average pricing and secure the real value of their improved product.[4]

While this evidence concerns middle dealers in the main district markets, about half of the rubber is first sold through lower levels. These additional marketing steps may increase the marketing margins because of greater real costs and possible monopsony profits. Increased costs arise primarily from higher transportation charges and the opportunity costs of the small traders. As one travels off the all-weather roads, the costs of transportation rise markedly. Systematic observation of prices successively farther from district centers suggests the increase in margins may be considerably larger than the increase in costs. The farther the producers are from the middle dealers, the less likely they are to have alternative price information or to consider sales in different markets. Moreover, the more remote village traders appear to profit particularly from excessive moisture deductions, disproportionately low prices for scrap, and their spectrum of multiple services. Although monopsony profits are suspected, the entry of new firms may, as in the case of monopolistic competition, squeeze them out at a level of price and volume below competitive norms.

The structure-conduct-performance framework has the advantage over partial analysis of testing conclusions about performance by their consistency within an interdependent equilibrium of relationships. At the exporter level, rapid price transmission and low, absolute margins are consistent with competitive performance, but the extremely unfavorable structural conditions and price-tying practices make this conclusion suspect. Other dimensions of performance, especially the variable returns on investment and the fringe of small, high-cost firms, provide powerful evidence of monopsony profits consistent with the comprehensive model. At the middle level, the structural conditions are more favorable and the GMOs bargaining indicates that monopsony profits, contrary to the conventional wisdom, are not prevalent. Although hard data are lacking, the apparently unsatisfactory performance at the lowest level of the market chain is consistent with market structure and conduct at that level.

Table 4. Margins and Profits in the Unsmoked Sheet Market: Data on the Group Marketing Organizations, 1969–71

	GMO A	GMO B
	(baht per kilogram)	
Range in margins	0.13–0.22	0.25–0.33
Less: smoking charge and transportation	0.20	0.20
Range in profits	0–0.02	0.05–0.13

Source: Margins, calculated on the day of each GMO transaction from 1969 to 1971, and estimated costs are from the Thailand Ministry of Agriculture, Rubber Research Centre.

The system's performance must also be evaluated by its degree of progressiveness as well as by the static criterion of the competitive model. The present quality of Thai sheet exports is notoriously low. The smoked sheet market transmits price signals which are qualitatively differentiated but which merge together into the average prices quoted for sheet in the unsmoked market. The practice of average pricing discourages the adoption of better processing techniques and penalizes the producer of higher grades unless he sells in large quantities as in a GMO. By the time the sheets are rolled by the producer, characteristics such as dirt content are fixed and the marketing system in its present form cannot improve their quality. For perpetuating a system which has failed to develop measures to improve quality, such as more careful grading or smoking at lower levels, the marketing system must be judged unprogressive.

While rubber has been sold in the form of ribbed smoked sheets and crepes for over fifty years, a new form of rubber, block rubber,

[4] The gains realized by the GMO members failed to stimulate expansion of groups without continuing extension services. The GMOs sold under 0.1% of 1972 production and seventeen of the seventy-three groups started since 1969 have been discontinued. Potential members perceived real costs in terms of the effort of improving quality and the loss of nonprice services provided by the trader, rather than perceiving a simple capture of monopsony profits.

was developed in Malaysia during the last decade. Block rubber is produced in factories where the latex, sheets, or scrap are converted into discrete particles which are pressed into blocks and graded by technical as opposed to visual specifications. Private investment in block rubber factories in Thailand has been discouraged by the poor quality of the raw materials, the government's pessimism concerning profitability, and differential export taxes which initially discriminated in favor of sheets. In spite of these difficulties, the large exporters had made a major commitment to the construction of block rubber capacity by 1974.

The high concentration in the smoked sheet market favors the rapid conversion to block rubber. The large exporters have the advantage of their favorable terms in the capital market and the opportunity to profit from the learning experiences which their related firms have had with block rubber in Malaysia and Singapore. External economies of scale favor a massive shift to block rubber, firstly, in order to establish the quality of Thai block rubber on the world market and, secondly, to create an alternative pattern of domestic demand with a higher and more differentiated set of price signals to be transmitted to the producers' level. Under the smoked sheet system the exporters pay for the grade distribution of sheets after smoking and have no monetary incentive to encourage the improvement of quality. Under a widespread block rubber system, the exporters will purchase unsmoked sheets, the quality of which will determine the standard of an entire batch of output, although the technical characteristics will not be known until testing and will be difficult then to trace back to individual suppliers. The first small block factories tailored their operations to accommodate the present flows of scrap and mixed sheets; with an abrupt and major shift in demand, there will be an incentive for cleanliness and consistency which should improve the specification and the quality of the flows.

The large exporters' size and market control permit them to convert the industry to block rubber more rapidly than in any other major producing country. This potential for progressive performance arises directly from the conditions of imperfect competition which would be condemned by static welfare criteria.

Analysis of the marketing system as a whole has led to different conclusions than partial analysis based upon selected elements in the system. The rubber-marketing industry cannot be fitted into the pure model of either competition or monopsony. Competition is imperfect or nonperfect, but it is workable in the sense that no administratively feasible alternative appears capable of transferring as much of the final price down to the producer level. This analysis also indicates that the government can make competition more workable by measures to increase the producers' bargaining strength, to encourage standardization of product quality, to improve the efficiency of the capital market, and by continuing to push feeder roads into remote producing areas to increase the size of effective markets.

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Market Intervention Policies When Production Is Risky

P. B. R. Hazell and P. L. Scandizzo

The supplies of many agricultural commodities involve important production risks. In analyzing market intervention policies, these risks should enter the analysis as stochastic elements in the slope of the supply function and not just in the intercept term. This specification leads to the result that optimally distorted prices are more efficient for social welfare than competitive market equilibrium prices. Important gains in social welfare may be obtained with risky products through the appropriate use of production quotas and price stabilization schemes designed to optimally distort the market.

Key words: risk, pricing policy, production quotas, stabilization schemes.

Theoretical analyses of market intervention policies are typically based on deterministic models of the market place. When risk is introduced as, say, for the analysis of price stabilization schemes, then the risky components of supply and demand are usually specified to be additive in nature, that is, the intercepts of the supply and/or demand schedules are specified as stochastic.

The supplies of many agricultural commodities, especially crop products, do not really conform to this kind of specification. Rather, production risks are multiplicative in nature, meaning that it is the slope of the supply function which contains the important stochasticities. This specification is suggested for two reasons: first, because it is usually crop area which is price responsive and total production (supply) is then total area times stochastic yield, and second, because the variance of total output increases with total area and is not a constant as assumed in an additive risk model. Multiplicative specifications are frequently used in empirical supply analysis, either in linear programming models (Hazell and Scandizzo) or in the econometric estimation of constant elasticity of substitution and Cobb-Douglas functions.

The purpose of this paper is to explore some of the implications of a multiplicative risk model. It is shown that such a model leads to the rather surprising result that optimally distorted market prices are more efficient for social welfare than the prices determined through a competitive market equilibrium. The implications of this result are explored in terms of desirable market intervention policies and as it affects conventional wisdom on price stabilization schemes and shadow pricing for project analysis.

The Model

In this paper, the supply and demand schedules are assumed linear and only supply is risky.[1] Specifically, the following market structure is assumed:

$$S_t = \lambda \epsilon_t P^*_t, \tag{1}$$

$$D_t = a - bP_t, \tag{2}$$

$$S_t = D_t, \tag{3}$$

and $E(\epsilon_t) = \mu$, $V(\epsilon_t) = \sigma^2$, cov $(\epsilon_t, P^*_t) = 0$ for all t, where P^*_t is the price anticipated by producers at the time of making production decisions, ϵ_t is stochastic yield, and a, b, and λ are positive constants.

The model has the following features. (a) Anticipated price, P^*_t, is the relevant forecast of P_t made by producers at the time of committing their inputs for period t. Typically, in agricultural production, there will be a lag between such decisions and the realization of production. As such, P^*_t incorporates antici-

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[1] There is little rationale for introducing a multiplicative risk term on the demand side, and an additive term does not effect the nature of the results unless correlated with ϵ.

pations about both ϵ_t and about demand and total supply. The assumption that $\text{cov}(\epsilon_t, P^*_t) = 0$ rules out the possibility of perfect forecasts (in which case the model would collapse to a simultaneous specification) and implies that no knowledge is available about ϵ_t other than that the parameters μ and σ^2 are known. (*b*) No specific assumptions are made about the risk behavior of producers, except that the aggregate supply schedule is upward sloping. However, it is well known that when risk aversion exists, the supply schedule will incorporate a new cost, the compensation to producers for taking risk (Magnusson, p. 65). Typically, this will mean that the supply schedule will have a greater slope coefficient than a risk-neutral supply schedule. (*c*) Because ϵ_t is multiplicative, the variance of market supply in each period is

$$V(S_t) = \lambda^2 P^{*2}_t \sigma^2,$$

and this increases with anticipated price. However, the coefficient of variation is

$$V(S_t)^{1/2}/E(S_t) = \sigma/\mu,$$

and this remains constant.

If the yield term ϵ is bounded on some positive interval $\epsilon_m \leq \epsilon \leq \epsilon_x$, then the market structure can be portrayed as in figure 1. The expected supply function $E(S) = \lambda\mu P^*$ is linear and passes through the origin. Since μ is assumed to be the best possible forecast of ϵ_t, $E(S)$ is the basic behavioral relation on the supply side. In the diagram, if producers anticipate $P^*_t = \rho_t$, then they will plan production for period t so that the expected market output is $S^*_t = \lambda\mu\rho_t$. However, because ϵ_t is stochastic, the actual supply function can ro-

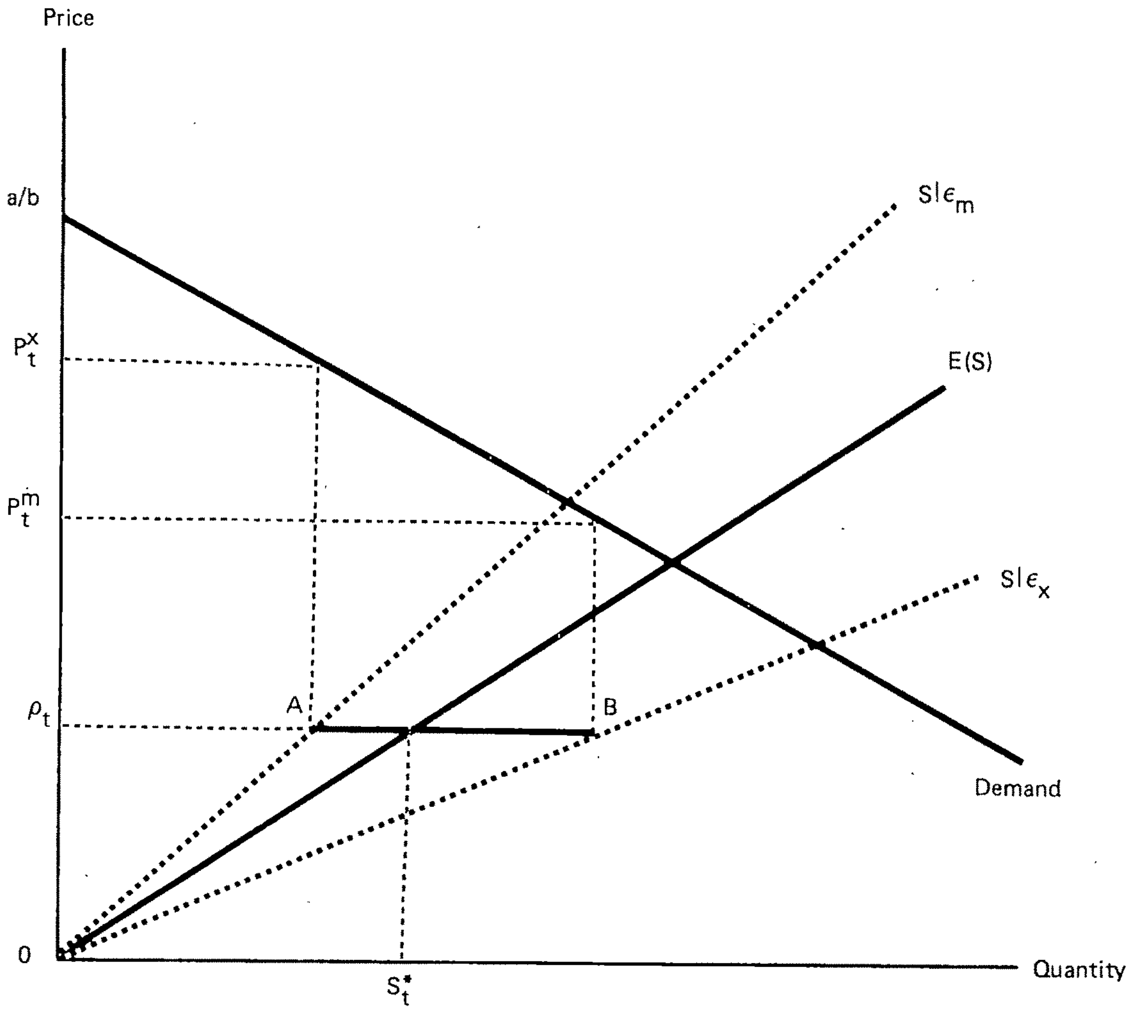

Figure 1. Market structure with risky supply

tate in a random way around $E(S)$ to any position contained in the funnel defined by $S|\epsilon_m = \lambda\epsilon_m P^*$ and $S|\epsilon_x = \lambda\epsilon_x P^*$. Hence, if expected supply in period t is S^*_t, actual supply could take on any value on the line AB in figure 1. Clearly, actual market price is stochastic with ϵ_t, and the actual price in period t may take on any value between P_t^m and P_t^x.

Since the market clears each period, market price is

$$(4) \qquad P_t = \frac{a}{b} - \frac{\lambda}{b}\epsilon_t P^*_t.$$

Further, since ϵ_t is stochastic, then P_t must always be stochastic. This means that if a competitive market equilibrium exists, it must be defined in terms of convergence properties of the probability density function of P_t. There are a number of concepts of equilibrium that can be used (Bergendorff, Hazell, and Scandizzo; Turnovsky 1968), but in this paper it is only necessary to consider convergence in the mean and variance of price. (A more complete and mathematical treatment of the convergence properties of this market structure is available in Bergendorff, Hazell, and Scandizzo.)

The Equilibrium Mean Price

Taking the expectation of equation (4) over ϵ_t and P^*_t, expected market price is[2]

$$(5) \qquad E(P_t) = \frac{a}{b} - \frac{\lambda}{b}\mu E(P^*_t).$$

Now if P^*_t is formed in such a way that $\lim_{t\to\infty} E(P^*_t) = \lim_{t\to\infty} E(P_t)$, that is, anticipated price is an asymptotically unbiased forecast, then it is clear that $E(P_t)$ will converge to a limiting value of

$$(6) \qquad \lim E(P) = \lim_{t\to\infty} E(P_t) = \frac{a}{b+\lambda\mu}.$$

As an example, consider the class of cobweb models in which

$$P^*_t = \sum_{i=1}^{m} \gamma_{t-i}P_{t-i} \text{ with} \sum_i \gamma_i = 1.$$

Here $E(P_t) = \frac{a}{b} - \frac{\lambda}{b}\mu \sum_i \gamma_{t-i}E(P_{t-i})$, which is an mth-order difference equation whose solution, if it exists, is indeed equation (6). As Bergendorff, Hazell, and Scandizzo have shown, a sufficient condition for convergence is that $\lambda\mu < b$ which is also the necessary condition for the naive cobweb in which $P^*_t = P_{t-1}$. In essence, this condition simply ensures that $\lim E(P^*_t) = \lim E(P_t)$.

The price $\lim E(P)$ in equation (6) has the property of being a self-fulfilling expectation, that is, if $\lim E(P)$ is the price anticipated by producers, then the expected value of the market clearing price will be $\lim E(P)$. This can easily be shown by substituting $P^*_t = \lim E(P)$ into equation (5) leading to the result $E(P_t) = \lim E(P)$. Lim $E(P)$ is therefore the rational expectation of the model in the Muthian sense. It is also the price corresponding to the intersection of demand and expected supply though, as Hazell and Scandizzo show (p. 239), this result depends critically on the linearity assumptions of the model.

The Equilibrium Variance of Price

Using equation (4), the variance of market price $V(P_t)$ defined over ϵ_t and P^*_t is[3]

$$V(P_t) = \frac{\lambda^2}{b^2} V(\epsilon_t P^*_t)$$
$$= \frac{\lambda^2}{b^2}[E(\epsilon_t^2 P^{*2}_t) - E(\epsilon_t^2)\, E(P^*_t)^2].$$

Assuming that cov $(\epsilon_t^2 P^{*2}_t) = 0$, then

$$V(P_t) = \frac{\lambda^2}{b^2}[E(P^{*2}_t)\mu_2 - E(P^*_t)^2\mu^2],$$

where μ_2 denotes the second moment of ϵ around 0. Adding and subtracting $\mu_2 E(P^*_t)^2$ and using $\sigma^2 = \mu_2 - \mu^2$ gives

$$(7) \quad V(P_t) = \frac{\lambda^2}{b^2}[\mu_2 V(P^*_t) + \sigma^2 E(P^*_t)^2].$$

Taking limits and again assuming $\lim E(P^*_t) = \lim E(P)$,

$$(8) \qquad \lim V(P) = \lim_{t\to\infty} V(P_t)$$
$$= \frac{\lambda^2}{b^2}\left[\mu_2 \lim V(P^*) + \frac{a^2\sigma^2}{(b+\lambda\mu)^2}\right].$$

The limiting variance of market price $\lim V(P)$ is therefore seen to be a linear function of the limiting variance of anticipated price $\lim V(P^*)$ and has its smallest value when $\lim V(P^*) = 0$. However, since it has been assumed that $\lim E(P^*_t) = \lim E(P)$, then the minimum value for

[2] $E(P_t) = E_{P^*}[E(P_t|P^*_t)] = \int\int P_t f(P^*_t,\epsilon_t)dP^*d\epsilon_t$ where P_t is of course a function of P^*_t and ϵ_t.

[3] $V(P_t) = E_{P^*}[E(P_t^2|P^*_t)] - E_{P^*}^2[E(P_t|P^*_t)]$.

lim $V(P)$ must occur exactly when producers anticipate the mean price lim $E(P)$ in each and every period. This supports Muth's contention that the self-fulfilling expectation is the most rational.

More generally, however, equation (8) says that the equilibrium variance of market price will be smaller the more accurate the anticipated price each period. Thus, in the class of cobweb models discussed earlier, Bergendorff, Hazell, and Scandizzo have shown that the naive cobweb has the largest lim $V(P^*)$ and hence the largest lim $V(P)$ and that the weighted cobwebs have progressively smaller lim $V(P^*)$ and lim $V(P)$ as P^*_t tends to lim $E(P)$.

A Welfare Analysis

The equilibrium mean price lim $E(P)$ in equation (6) was derived under the quite reasonable assumptions that the market converges and that on average, producers settle on the self-fulfilling expectation as their anticipated price. It is now appropriate to consider whether this price is also a welfare-maximizing price.

Following Massell and Turnovsky (1974), social welfare will be measured using the expected values of the consumers' and producers' surplus. Consumers' surplus is the expected value of the area under the demand curve and above actual market price P_t. Algebraically,

$$W_t = \int_{P_t}^{a/b} (a - bP)dP,$$

which after some algebra evaluates at $W_t = \lambda\,\epsilon_t^2 P^{*2}_t/2b$. Taking expectations over ϵ_t and P^*_t and adding and subtracting $\frac{\lambda^2\mu_2}{2b}\cdot E(P^*)^2$, gives

$$\text{(9)}\qquad E(W) = \frac{\lambda^2\mu_2}{2b}\,[V(P^*) + E(P^*)^2].$$

To evaluate the producers' surplus (or realized profit), it is necessary to recognize that production costs incurred in period t depend on anticipated price P^*_t and not on actual price P_t. This is because the model is specified with lagged production and less than perfect price forecasts. Diagrammatically, the surplus can be shown as in figure 2. Suppose producers again anticipate $P^*_t = \rho_t$ for period t, so that expected market supply is S^*_t. Production costs are then the value of the triangle OBS^*_t and these become fixed for period t regardless of the outcomes for ϵ_t and P_t. Producers' revenue depends directly on actual yields and prices. Suppose actual supply is S_t in figure 2. Then actual market price is P_t and producers' revenue is the area of the rectangle OP_tCS_t. The producers' surplus for period t is therefore $OP_tCS_t - OBS^*_t$.

Algebraically, the producers' surplus is calculated as follows:

$$\Pi_t = P_tS_t - \int_0^{S^*_t = \lambda\mu P^*_t} \frac{S}{\lambda\mu}\, dS,$$

that is, total actual revenue minus total costs as measured by the area under the expected supply function from 0 to S^*_t. After some algebra,

$$\Pi_t = \frac{a}{b}\,\lambda\epsilon_t P^*_t - \left(\frac{\lambda^2}{b}\epsilon_t^2 + \frac{\lambda\mu}{2}\right) P^{*2}_t.$$

Hence, taking the expectation over ϵ_t and P^*_t and adding and subtracting $\left(\frac{\lambda^2}{b}\,\mu + \frac{1}{2}\,\lambda\mu\right) E(P^*)^2$,

$$\text{(10)}\qquad E(\Pi) = \frac{a}{b}\,\lambda\mu\, E(P^*) - \left(\frac{\lambda^2}{b}\,\mu_2 + \frac{1}{2}\,\lambda\mu\right) V(P^*) - \left(\frac{\lambda^2}{b}\,\mu_2 + \frac{1}{2}\lambda\mu\right) E(P^*)^2.$$

The social welfare measure $E(SW)$ used here is the sum of the expected values of the consumers' and producers' surplus. Adding equations (9) and (10) together,

$$\text{(11)}\qquad E(SW) = \frac{a}{b}\,\lambda\mu\, E(P^*) - \frac{1}{2}\left(\frac{\lambda^2}{b}\,\mu_2 + \lambda\mu\right) V(P^*) - \frac{1}{2}\left(\frac{\lambda^2}{b}\,\mu_2 + \lambda\mu\right) E(P^*)^2.$$

The expected value of social welfare is therefore a function of the mean and variance of the price anticipated by producers at the time of making their decisions. For any fixed $V(P^*)$, the maximum of this function occurs when

$$\frac{\partial E(SW)}{\partial E(P^*)} = \frac{a}{b}\,\lambda\mu - \left(\frac{\lambda^2}{b}\,\mu_2 + \lambda\mu\right) E(P^*) = 0,$$

that is, when the expected value of producers' anticipated price is

$$\text{(12)}\qquad E(P^*) = \frac{a\mu}{b\mu + \lambda\mu_2}.$$

Since equation (11) is a decreasing function

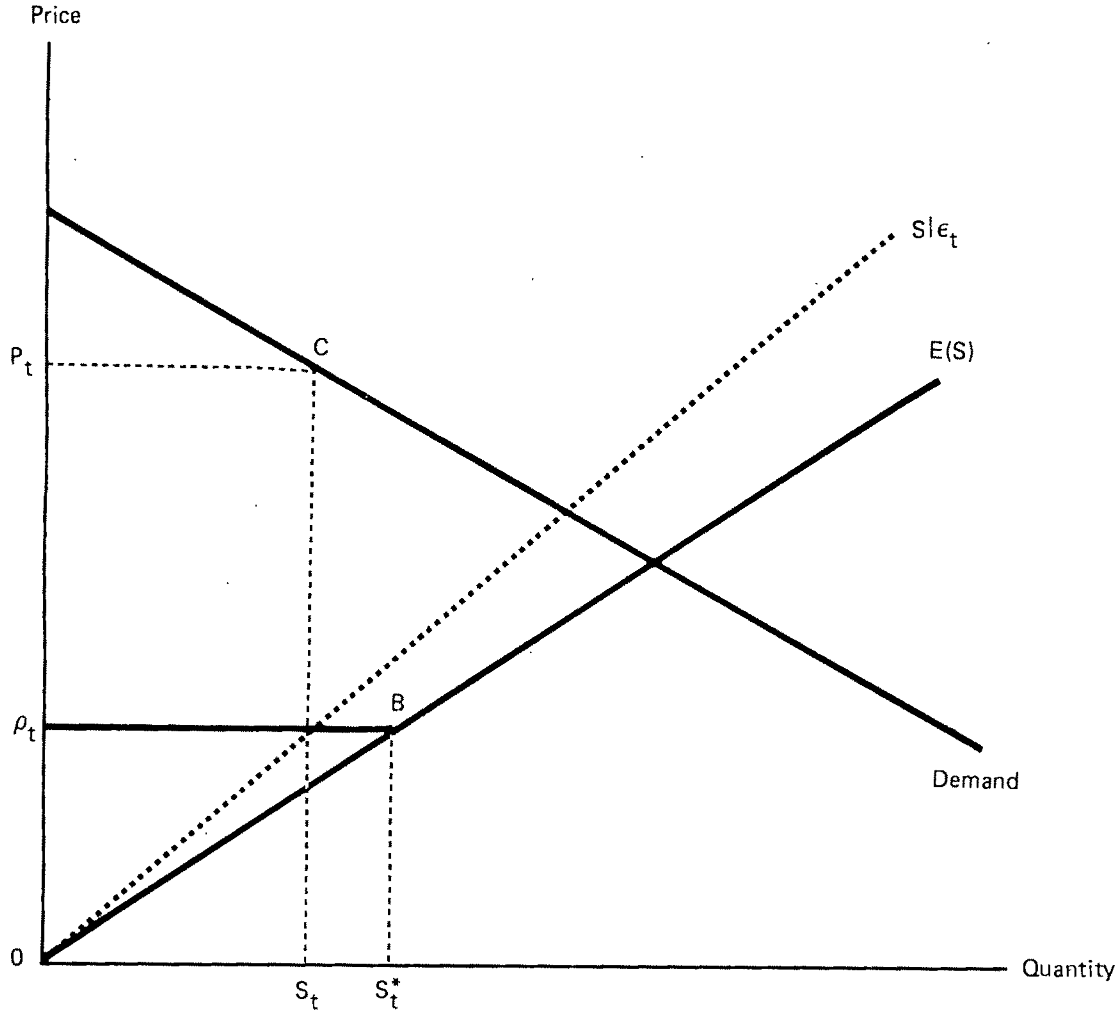

Figure 2. Producers' surplus under alternate supply conditions

in $V(P^*)$, the global maximum occurs when $V(P^*) = 0$, that is, when producers anticipate $a\mu/(b\mu + \lambda\mu_2)$ in each and every period.

Assuming equation (12) is satisfied, then by substituting equation (12) into equation (5) and taking expectations, the expected market clearing price would be[4]

$$(13) \qquad E(P_t) = \frac{a(b\mu + \lambda\sigma^2)}{b(b\mu + \lambda\mu_2)}.$$

Equation (13) is not the market equilibrium price lim $E(P)$ derived earlier in equation (6) nor is equation (12) a self-fulfilling expectation; yet it is this combination of anticipated and expected prices which maximizes the selected measure of social welfare. This is a somewhat surprising result, for it implies that there is an optimal distortion for the market.

Taking the ratio of equations (12) and (13) and simplifying,

$$(14) \quad \frac{E(P^*)}{E(P_t)} = \frac{b\mu}{b\mu + \lambda\sigma^2} = \frac{|\xi_d|}{|\xi_d| + R^2},$$

where $|\xi_d| = \dfrac{b}{\lambda\mu}$ is the absolute value of the elasticity of demand evaluated at the competitive market equilibrium, and R is the coefficient of variation for ϵ, that is, $R = \sigma/\mu$.

Clearly this ratio is less than 1, so that $E(P^*) < E(P_t)$. Further, taking the ratio $E(P^*)$/lim $E(P)$ and simplifying,

$$(15) \quad \frac{E(P^*)}{\lim E(P)} = \frac{b\mu + \lambda\mu^2}{b\mu + \lambda\mu_2} = \frac{|\xi_d| + 1}{1 + |\xi_d| + R^2},$$

[4] Note that once P^*_t is fixed over time, the market automatically attains a new equilibrium so that there is no need to consider the asymptotic properties of $E(P_t)$.

which is also less than 1 because $R^2 > 0$. Hence, $E(P^*) < \lim E(P)$.

Taking these two results together, the optimal distortion involves a cutback in production compared to the competitive equilibrium. Producers should plan on the basis of a lower expected price than the competitive equilibrium price $\lim E(P)$, and as a result they will realize a higher market price on average.

The derivation of equation (12) guarantees that this strategy leads to the maximum gains to consumers and producers as a whole, and hence $E(SW)$ is larger when producers anticipate equation (12) rather than $\lim E(P)$. The way in which this gain is allocated among consumers and producers can be seen by using equations (9) and (10). For the same $V(P^*)$, consumers gain as $E(P^*)$ increases while producers lose. Since $E(P^*)$ in equation (11) is smaller than $\lim E(P)$, the distortion benefits producers at the expense of consumers.

The Nature of the Distortion

The existence of an optimal distortion price requires some explanation. In a very different context, Brainard has also shown how a multiplicative risk model can lead to unconventional results. Basically, it can be attributed to two factors in the model specification: first, because production costs are dependent on anticipated price P^*_t and not on actual market price P_t. This means that there is no fixed relationship between revenue and costs and that for some P^*_t, the yield ϵ_t outcome may, in conjunction with the inelasticity of demand,[5] conspire to cause revenue to fall below costs to the extent that there is a net welfare loss to society. In itself, this cost is not sufficient to distort the market.[6] However, because of a second feature of the model, the multiplicative risk term, the variance of market supply S_t increases quadratically as producers move up the expected supply function, so that the possibility of costs exceeding revenue also increases. Clearly, the distortion in the market arises from the trade-off between the surpluses from higher outputs and the net welfare loss associated with wasted resources.

Let F denote the ratio of expected market-clearing price assuming an optimal distortion to the expected market-clearing price given a competitive equilibrium, that is, $F = E(P_t)/\lim E(P)$, where $E(P_t)$ is defined in equation (13). Then $T = (F\text{-}1)100\%$ measures the percentage market price distortion, having a value of 0 when the optimally distorted price $E(P_t)$ is the same as the equilibrium price $\lim E(P)$. Using equations (14) and (15),

$$(16)\qquad T = \frac{R^2\ 100\%}{|\xi_d|(|\xi_d| + R^2 + 1)};$$

T is therefore seen to be a function of the demand elasticity evaluated at the competitive market equilibrium and the coefficient of variation of ϵ. For fixed R the distortion is larger the more inelastic the demand, but the distortion disappears at the limit as the demand elasticity is increased towards infinity. The distortion also increases with R, so that the more risky the production the greater the optimal market price distortion. In a deterministic market, $R = 0$ and the optimal distortion is 0.

In order to provide some feel for the magnitudes of the optimal distortions involved, T has been calculated for various values of ξ_d and R in table 1. It is often claimed that the aggregate demand for agricultural commodities is inelastic. If this is so (say for non-traded goods), then for only moderate degrees of production risk ($R = 0.5$), the optimally distorted market price $E(P_t)$ should be at least 11% higher than the competitive market equilibrium price $\lim E(P)$. For higher risk situations, the optimal distortion ratio becomes quite large indeed for inelastic demands.

Given the size of these distortions, it is pertinent to inquire into the magnitudes of the associated welfare gains. Using equation (11), these can be expressed in terms of percentage gains as

$$Z = |G|\ 100\%,$$

where $G = \dfrac{E^*(SW) - \lim E(SW)}{\lim E(SW)}$ and $E^*(SW)$ and $\lim E(SW)$ denote, respectively, the expected social welfare assuming producers anticipate $E(P^*)$ as defined in equation (12) and the equilibrium price $\lim E(P)$ as defined in equation (6). For simplicity, suppose producers anticipate these prices in each period so that $V(P^*) = 0$; then, after some algebra,[7]

[5] Remember linear demand curves become increasingly inelastic as the quantity increases.

[6] In an additive risk model, for example, with the same kind of lagged specification, a price distortion does not arise.

[7] Substituting equation (12) for $E(P^*)$ in equation (11), setting $V(P^*) = 0$ and simplifying,

$$E^*(SW) = \frac{a^2\mu^2\lambda}{2b(b\mu + \lambda\mu_2)}.$$

Table 1. Percentage Price Distortions (*T*) and Percentage Welfare Gains (*Z*) for Variations in Market Parameters

	$R = 0.25$		$R = 0.5$		$R = 1.0$		$R = 2.0$		$R = 3.0$	
ξ_d	T	Z	T	Z	T	Z	T	Z	T	Z
−0.50	8.0	0.2	28.6	2.8	80.0	80.0	145.5	116.4	171.4	102.9
−0.75	4.6	0.1	16.7	2.1	48.5	48.5	92.8	123.7	111.6	103.9
−1.00	3.0	0.1	11.1	1.6	33.3	33.3	66.7	133.3	81.8	105.2
−2.00	1.0	0.0	3.8	0.7	12.5	12.5	28.6	228.6	37.5	112.5
−5.00	0.2	0.0	0.8	0.2	2.9	2.9	8.0	80.0	12.0	180.0
−10.00	0.1	0.0	0.2	0.1	0.8	0.8	2.7	15.2	4.5	202.5
−50.00	0	0	0	0	0	0	0.1	0.6	0.3	3.2

$$G = \frac{(|\xi_d| + 1)^2}{(|\xi_d| + 1 + R^2)(|\xi_d| + 1 - R^2)} - 1.$$

Values of Z are reported in table 1 for the corresponding values of T. When $R = 0.5$ and demand is inelastic, the optimal distortion leads to a welfare gain of at least 1.6%. This corresponds to the price distortion of 11%. Generally, the welfare gains from the distortion are quite small for low R and might be ignored. However, for R-values of 1.0 or larger, the welfare gains are disturbingly large. For example, if $R = 1.0$ and the elasticity of demand is −0.75, expected social welfare can be increased by 48.5% by optimally distorting a competitive market.

It might be objected that the magnitudes of these distortions and welfare gains result from the simplifying linearity assumptions of the model. However, the linearity assumptions are least important when demand is inelastic, and it is exactly in these cases that the significant results are obtained.

Market Intervention Policies

The existence of an optimal price distortion suggests a rather new rationale for market intervention policies in competitive markets. They should be used to reduce the expected market supply from $a\lambda\mu/(b + \lambda\mu)$, the level realized in a competitive equilibrium, to $a\lambda\mu^2/(b\mu + \lambda\mu_2)$, the output corresponding to the optimal distortion price in equation (13). This would raise the average market price from the competitive equilibrium level but in so doing would actually raise the level of aggregate social welfare as measured by the sum of expected values of the consumers' and producers' surplus.

An obvious and effective way to achieve this goal would be through a system of production or marketing quotas. Perhaps these should be regarded as a social norm for agricultural markets in which production is risky and demand is price inelastic!

The optimal distortion can also be implemented, at least partially, through appropriate use of price stabilization schemes and, in developing countries, through the shadow prices used in project appraisal.

Price Stabilization Schemes

Equation (11) shows that for fixed $E(P^*)$, the realized social welfare $E(SW)$ increases as the variance of anticipated price $V(P^*)$ is reduced. However, from equation (7) it is known that the variance of actual market price $V(P_t)$ is a linear and increasing function of $V(P^*)$ so that any price stabilization scheme which leaves $E(P^*)$ unchanged must lead to a gain in total welfare. It is also clear from equation (9) that consumers lose through price stabilization while equation (10) indicates that producers gain. These results are consistent with results obtained by Waugh, Oi, Massell, and Turnovsky (1974) for additive risk models.

The optimal stabilization scheme to maximize $E(SW)$ is obviously one in which

Similarly, by substituting equation (6) for $E(P^*)$ in equation (11), setting $V(P^*) = 0$, and simplifying,

$$\lim E(SW) = \frac{a^2\lambda(b\mu + 2\lambda\mu^2 - \lambda\mu_2)}{2b(b + \lambda\mu)^2}.$$

Therefore,

$$G = \frac{E^*(SW) - \lim E(SW)}{\lim E(SW)} = \frac{E^*(SW)}{\lim E(SW)} - 1$$

$$= \frac{\mu^2(b + \lambda\mu)^2}{(b\mu + \lambda\mu_2)(b\mu + 2\lambda\mu^2 - \lambda\mu_2)} - 1.$$

Using $|\xi_d| = \dfrac{b}{\lambda\mu}$ and $R^2 = \dfrac{\mu_2}{\mu^2} - 1$ and performing suitable algebraic operations, the expression for G in terms of $|\xi_d|$ *and* R^2 is obtained.

$V(P_t) = V(P^*) = 0$, and producers are paid a fixed price of $P^* = a\mu/(b\mu + \lambda\mu)$. Since then $E(P_t) > P^*$, there is a "natural" margin on average to cover storage and administration costs and there may even be a profit for the stabilizing agency. Such a scheme, while socially desirable may not benefit producers, however, unless they also share in the profits of the stabilizing agency. Of course, unless there was a quota system constraining output to correspond with the anticipated price P^*, any producers' share of profits would have to be transferred in a suitable manner, say through a dividend scheme, so as not to increase their anticipated price P^*.

It is interesting to consider the maximum profit that the stabilizing agency can extract without leaving producers any worse off than before stabilization.[8] Put another way, what fixed price (call it P') must producers be paid each period if their average realized profits are to remain the same as they would be in a competitive market equilibrium? To answer this question it is convenient to assume that production is constrained through a quota scheme to correspond to the anticipated price $P^* = a\mu/(b\mu + \lambda\mu_2)$ and that the stabilizing agency therefore realizes an average market price of $E(P) = \dfrac{a(b\mu + \lambda\sigma^2)}{b(b\mu + \lambda\mu_2)}$ as derived in equation (13). To simplify matters further, let it also be assumed that in the equilibrium and unstabilized state, producers anticipated the mean price $\lim E(P)$ in each and every period, so that the variance of anticipated price is 0.

Now since producers receive the fixed price P' but act as if they anticipate P^*, their realized average surplus is

$$E(\Pi) = E(S_t P') - \frac{1}{2} E(S|P^*)P^*$$
$$= \lambda\mu P^* P' - \frac{1}{2}\lambda\mu P^{*2}.$$

The problem is to find P' which equates the above average surplus with that realized under the competitive situation in which producers anticipate $\lim E(P)$. This surplus is, using equation (10),

$$E(\Pi) = \frac{a}{b}\lambda\mu \lim E(P) - \frac{\lambda}{2b}(2\lambda\mu + b\mu) \lim E(P)^2.$$

Hence, equating the two surpluses and solving for P' gives

$$P' = \frac{a}{b}\left(\frac{\lim E(P)}{P^*}\right) - \left(\frac{2\lambda\mu_2 + b\mu}{2b\mu}\right)\left(\frac{\lim E(P)^2}{P^*}\right) + \frac{1}{2}P^*.$$

It is not too difficult to derive the conditions under which P' must be larger than P^*. This is when $P' - P^* > 0$ or equivalently when

$$\frac{a}{b}\left(\frac{\lim E(P)}{P^*}\right) - \left(\frac{2\lambda\mu_2 + b\mu}{2b\mu}\right)\left(\frac{\lim E(P)^2}{P^*}\right) - \frac{1}{2}P^* > 0.$$

This can be simplified to

$$\frac{2a\mu}{\lim E(P)} - (2\lambda\mu_2 + b\mu) > b\mu\frac{P^{*2}}{\lim E(P)^2}$$

and, using $\lim E(P) = a/(b + \lambda\mu)$ on the left-hand side,

$$b\mu - 2\lambda\sigma^2 > b\mu\frac{P^{*2}}{\lim E(P)^2}.$$

Rearranging terms and using $|\xi_d| = b/\lambda\mu$, this reduces to

$$\text{(17)}\qquad \frac{1}{2}|\xi_d|\left[1 - \left(\frac{P^*}{\lim E(P)}\right)^2\right] > R^2.$$

As previously shown, $P^* < \lim E(P)$ so that the left-hand side of equation (17) is positive. Hence, for any $|\xi_d| \leq 1$, R would have to be considerably smaller than ½ if producers are not to require a price P' greater than P^* to maintain their surplus.[9]

Shadow Prices for Project Analysis

Shadow prices for agricultural products are typically used in project analysis to remove market price distortions arising from overvalued foreign exchange rates. As such, they serve to increase the value of the product (improving the desired terms of trade between the agricultural and nonagricultural sectors) and encourage agricultural investments.

The results in this paper suggest a rather

[8] The possible existence of such a surplus suggests a useful way of taxing agriculture, namely through a government-run stabilization agency.

[9] The fact that P' may be less than $\lim E(P)$ let alone less than P^* is a little surprising, since it might be expected that only if $P' > \lim E(P)$ could $E(\Pi)$ be maintained with the lower expected supply. The result reflects the substantial gains to be had from price stabilization when demand is linear. This is because with linear demand and unstabilized prices, large (small) outputs tend to lead to price determination on the inelastic (elastic) part of the demand schedule, and in both cases the revenue effect is unfavorable for producers, leading to a low producers' surplus on average.

perverse role for shadow prices. Products should be valued at the optimal anticipated price $a\mu/(b\mu + \lambda\mu_2)$ in equation (12), which is less than the expected price at market equilibrium. This means that projects for risky commodities should be penalized. Again, the rationale for this lies in the social cost of wasted resources associated with periods in which production costs exceed revenue and these costs increase with expected production.

Shadow pricing in this way would not only penalize risky products but might seem to actually worsen the desired terms of trade for agriculture. However, in this case the shadow price used for guiding investment decisions is not really the desired realized price. This is $a(b\mu + \lambda\sigma^2)/b(b\mu + \lambda\mu_2)$ as derived in equation (13), which would be higher than the market equilibrium price. Because of this, the desired terms of trade to be realized for agriculture might still improve.

Conclusions

This paper demonstrates that when risk enters the market supply schedule in a multiplicative way, then the expected price and output determined in a competitive market equilibrium may not necessarily be the best in terms of social welfare. Rather, there exists an optimal market distortion involving a higher average price and lower expected supply. This optimal price distortion can not only be quite large when demand is inelastic (more than 10% with moderate production risks), but important welfare gains may be had from using market intervention policies to introduce the desired distortion. Such policies might take the direct form of a quota system or, less directly, include appropriate use of price stabilization schemes and shadow prices for project analysis.

These results have been obtained using a number of simplifying assumptions. In particular, it has been assumed that supply and demand schedules are linear, that supply has unity elasticity throughout, and that the sum of the expected values of the consumers' and producers' surplus is a suitable measure of social welfare. Changing these assumptions does of course lead to some modifications in the results. For example, introducing nonlinearities can, though not necessarily, reduce the size of the optimal distortion, while introducing an intercept term in the demand schedule increases or reduces the size of the optimal distortion depending on whether the supply elasticity at equilibrium is less than or greater than unity. (The derivation of these and other extensions are available from the authors upon request.) Perhaps the most important limitation of the analysis is the measure of social welfare used. The consumer surplus does not, for example, consider income effects arising from changes in the price of the marketed commodity. In a developed country context where food is but a small part of consumers' expenditure, this shortcoming might be ignored but extreme caution is necessary in interpreting the results for developing countries if the marketed commodity is an important wage good. These problems require more sophisticated analysis before final policy conclusions can be drawn, but the problem of optimal distortions is likely to remain.

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Education and Allocative Efficiency in U.S. Agriculture

Nabil Khaldi

Rapid technological change creates production uncertainty with a consequent decline in allocative efficiency; productivity growth appears to augment the comparative advantage of large farms, which alongside rising operator education implies scale economies in the use of information. A method is provided for measuring cost inefficiency due to changes in input mix and failure to produce optimum output which is related to growth in farm size. Statistical results provide support for the hypothesis that education enhances allocative efficiency.

Key words: allocative efficiency, education, agricultural research, cost inefficiency, optimum output, information, scale economies.

The role of education in agricultural productivity has been examined in a number of studies. Education enters the aggregate production function as an explicit input with its estimated coefficient as the only source of productivity (Gisser, pp. 582–84; Griliches 1963, pp. 961–65; Griliches 1964, pp. 335–36; Kislev, pp. 61–68). In this sense, the marginal product of education captures the "worker effect" of education, reflecting the increases in output while holding physical resources constant.[1]

In a dynamic agriculture, however, research activities—both basic and applied—augment the stock of scientific knowledge and yield new and improved inputs. As producers face a less than perfect familiarity with the "new things," they at any point in time will be making production errors. Hence, productive research activities create and perpetuate disequilibrium in modern farming. Education may improve the decision-making process and thereby influence the level and/or the composition of other inputs. In this setting, an estimate of the worker effect of education, as reported in the productivity studies quoted above, represents an underestimation of the total effect of education in production.

Thus, in an economic environment where new inputs are appearing and relative prices are changing, the presence of disequilibrium yields excessive costs and creates an incentive for decision makers to learn and adjust their activities.[2] The extent to which education may enhance farmers' ability to respond to these new growth opportunities implies that, for this input, there does exist an allocative effect in agricultural production.[3]

In this study, allocative decisions are a particular set of activities devoted to reduction of *ex post* errors in the first-order conditions. These errors are then decomposed into both the minimization of input mix and the choice of the optimum output (scale effect).

The objective of this study is to identify the

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[1] Worker effect of education is distinguished from allocative effect—a central part of this investigation—which reflects the managers' ability to acquire and decode information about productive characteristics and costs of other inputs and refers to covariation between education and other inputs.

[2] This contrasts the static traditional agriculture where farmers are dependent on factors which they are accustomed to and may also learn a particular efficient set of techniques passed on from one generation to the next. Agricultural production activities in this sense are in long-run equilibrium (complete adjustments) since nothing is, or has been, happening. These implications are found in the works of J. W. Mellor and T. W. Schultz (1964).

[3] In his analysis of the midwestern U.S. farmer's adjustment to the changing optimum quantity of nitrogen fertilizer in corn production, Huffman clearly demonstrates a dimension of allocative effect of education in a dynamic environment. Another dimension was stressed earlier by Nelson and Phelps' hypothesis that education enhances innovative ability as it speeds the process of technological diffusion.

errors and to show that in the presence of disequilibrium conditions, education contributes to allocative efficiency. Accordingly, links between allocative efficiency and operator education are examined in relation to these errors.

The first is error of cost inefficiency which measures the proportion by which observed cost exceeds minimum cost for given output. Changes in the inefficiency indexes, due to changes in input mix, are then linked to the allocative effect from education. To derive the inefficiency measure, a model has been developed where a production function for 1964 U.S. agriculture is estimated; from that function optimal input quantities are imputed and their implications are then analyzed.

The second error is in scale—the opportunity loss from failure to produce optimum level of output—and is closely related to adjustments in farm size. So long as the forces which result in scale economies provide incentives for farm size expansion, there is support for the comparative advantage of large farms. The perspective is that these forces may not only have enhanced the comparative advantage of large farms, but also in the context of dynamic agriculture they have created economies of scale in the use of information. Thus, as average schooling increases with farm size (schooling facilitates learning), there may be additional gain from education through the choice of optimum rate of output (i.e., profit maximization). Implications from these hypotheses are presented.

The Production Function: Data and Estimation

A necessary step for computation of cost minimization level for material inputs requires the estimation of a production function. Assuming a Cobb-Douglas type of production function for 1964 U.S. agriculture, the relationship may be expressed as

$$(1) \qquad Y_j = A_0 \prod_{i=1}^{5} X_{ij}^{\beta_i} R_j^{\alpha_1} E_j^{\alpha_2},$$

where Y is the expected output, $X_1, \ldots X_6$ are material inputs (land, machinery, labor, fertilizer, livestock, and miscellaneous), R and E are research and education inputs respectively with β_i's, α_1 and α_2 as the corresponding elasticities of production; A_0 is a constant.

The dependent variable Y_i is gross agricultural output in dollars for the average farm in state J and measured in 1964 prices. Total value of output is built up from farm products sold, home consumption, net changes in inventories, and government payments which are deflated separately by an appropriate U.S. price index.

All factors of production are also on a per farm basis. Inputs in value terms, which are measured in 1964 state prices, are adjusted cross sectionally by appropriate U.S. price indexes. Acres per farm is used to measure land area in the production function.[4]

The machinery variable input is a measure of the estimated services from selected farm machinery plus expenditure on fuel, custom hire, and contract work of machine services. The imputed services are estimated to be 17% of the stock value of machinery, which corresponds to a 10% interest cost of capital plus 7% annual depreciation. The 17% is assumed to be constant over state and between the stock value and the flow of the services.[5]

The labor variable measured in physical flow units is defined as the annual days of employment. The input which is computed the same as that reported by Griliches includes operators' labor and family and hired labor (1964, p. 974). The physical labor is adjusted for operators over 65 years at 0.6 and for labor supplied by other family members at 0.65. No attempt is made, however, to adjust for quality differences.

Actual physical quantities of fertilizer which include dry and liquid material are evaluated by state prices to account for the input expenditure.

The livestock and miscellaneous variable is the sum of the imputed services of the livestock value (10% of the capital) in addition to expenditures on seed and feed for livestock and poultry. Livestock capital which includes milk cows, other cattle, hogs, pigs, sheep, lambs, and chickens are evaluated at per head state prices. The seed component also includes expenses on bulbs, plants, and trees.

Education input denotes the human capital generated in the schooling process for farm operators. The measure is based on years of school completed by farm operators weighted

[4] Acres per farm measure involves errors since it ignores diversity of land fertility and soil quality. However, an alternative measure for this input in value terms can also be biased due to the site value of land.

[5] The 1959 regional prices for selected machinery, as reported by Kislev, were adjusted to compute the 1964 stock value of the capital.

Table 1. Agricultural Production Function for the United States, 1964

	Regression Results			
	1		2	
Variable	Coefficient	Standard Errors	Coefficient	Standard Errors
X_1 Land	0.110	0.023	0.095	0.023
X_2 Machinery	0.153	0.052	0.225	0.059
X_3 Labor	0.503	0.080	0.399	0.094
X_4 Fertilizer	0.168	0.021	0.171	0.020
X_5 Livestock, etc.	0.319	0.037	0.272	0.039
R Research			0.054	0.026
E Education			14.194	7.813
Intercept	1.241		1.486	
R^2	0.968		0.979	
β_i	1.253		1.162	
D_f Degrees of freedom	33		31	

Source: All data for variable inputs are obtained from the U.S. Dep. of Commerce (1966) unless otherwise specified in the text.

by national income for the respective schooling class data (U.S. Dep. of Commerce 1963).

Research input defines a process by which flows of services provided by capital (human and nonhuman) are transformed into other types of capital such as improved machinery, seed and fertilizers, production, and managerial ability. The imputed services of this input is assumed to approximate the opportunity cost, which in turn in production is assumed to be equal to public expenditure on research.[6]

Regression results from ordinary least squares estimates of the log linear production functions are reported in table 1.[7] All variables for both equations in the table are defined in value terms except land and labor, which are reported in physical units.[8] The results exclude education and research from the list of inputs in one of the estimated equations.

The t-ratios for material inputs in both equations are relatively large. Those of education and research are somewhat smaller but still near 2.[9] The R^2 for the second regression equation in table 1 shows that the inputs account for 98% of the variation in aggregate U.S. agricultural output across states. The increase in R^2 for this equation along with the estimated coefficients clearly support the hypothesis that both education and research belong in the production function.[10]

None of the regression results are very surprising in light of a priori expectation or other comparable aggregate production estimations. The ratio of marginal revenue product to marginal cost is about 1 for labor (1.09). It is less than 1 for land (0.725) and greater than 1 for machinery (1.20) with livestock plus miscellaneous at 1.45 and fertilizer at 1.88. The implication of the regression results is that for the year 1964, modern inputs such as capital machinery and fertilizer are still underutilized.

Inefficiency Indexes: Measurement and Regression Results

Statistical estimates of production coefficients are basically a means for solving the cost

[6] Following Evenson, the total research expenditures are estimated for each of nine years ending in 1959 and are averaged using inverted "V" weights over the period. Average annual research is then divided by the number of farms in the state.

[7] Simultaneous equation bias is assumed away since input decisions, with the exception of harvesting cost, largely refer to anticipated rather than realized output. In an alternative specification, Griliches found little difference between ordinary least squares and instrumental variable estimators when instruments were introduced for the labor input (1964, p. 965).

[8] Estimation bias that occurs from the use of value rather than quantity data in cross-section study would be minimum as long as relative price differences are mainly limited to transportation costs, the exceptions being land and labor inputs. In the case of labor, one encounters large variations in the price per unit, while a value measure of land includes errors due to "pure site rent." However, alternative estimation of production where labor and land are specified in value terms has not greatly altered the statistical results reported in table 1.

[9] It should be pointed out that pervasiveness of research activity, particularly in cross-section estimation, may diminish the effect of state research on output and results in a downward bias for its coefficient. Also, according to Evenson, exclusion of expenditures on private research activity results in a substantial downward bias although a portion of this excluded effect may be partially captured in the input-price measure.

[10] In a gross revenue production formulation, the implied marginal product of education includes, in addition to Welch's worker effect, the allocative effect within the material input bundles (1970). This is related to the managers' ability to move gross revenue closer to the optimum level. Both the worker effect and this part of Welch's allocative effect are essentially those reported on the contribution of education from fitting 1949, 1954, and/or 1959 agricultural data to aggregate production.

minimization model since they are used to derive measures of cost inefficiency. According to standard theory, the minimum cost of producing output given the production function and the factor prices for a competitive firm may be stated as

$$(2)\quad \frac{\beta_1 Y_j}{P_{1j}X^*_{1j}} = \frac{\beta_2 Y_j}{P_{2j}X^*_{2j}} = \frac{\beta_3 Y_j}{P_{3j}X^*_{3j}} = \frac{\beta_4 Y_j}{P_{4j}X^*_{4j}} = \frac{\beta_5 Y_j}{P_{5j}X^*_{5j}}$$

where $j = 1, \ldots 39$ are observations of production in states. The asterisk designates the optimum level of factor input with β_i and P_i, respectively, as the production coefficient and the price for each of the respective inputs.

For convenience, equation (2) may be written in the form

$$(3)\quad X^*_{kj} = \frac{\beta_k P_{1j}}{\beta_1 P_{kj}} X^*_{1j} \qquad k = 2,3,4,5.$$

When substituting equation (3), the estimated U.S. production equation for 1964 becomes

$$(4)\quad Y_j = A_0 R_j^{\alpha_1} E_j^{\alpha_2} X^{*\,\beta_1}_{1j} \left(\frac{\beta_2 P_{1j}}{\beta_1 P_{2j}} X^*_{1j}\right)^{\beta_2} \left(\frac{\beta_3 P_{1j}}{\beta_1 P_{3j}} X^*_{1j}\right)^{\beta_3} - - - \left(\frac{\beta_5 P_{1j}}{\beta_1 P_{5j}} X^*_{1j}\right)^{\beta_5}.$$

To derive the solution for each factor input, equation (4) may be expressed as

$$(5)\quad X^*_{1j} = \left(\frac{Y_j \prod_{i=1}^{5}\left(\frac{\beta_1 P_{ij}}{\beta_i P_{1j}}\right)^{\beta_i}}{A_0 R_j^{\alpha_1} E_j^{\alpha_2}}\right)^{1/\Sigma\beta_i}.$$

This provides the solution for the cost minimization level of X^*_{1j} (the base input land) in terms of the value of output, a constant, and the coefficients of the estimated production equation reported in table 1.

Let C^*_j and C_j denote the optimum value of material input aggregates, and let the actual cost of the variable inputs selected be respectively expressed as

$$(6)\quad C^*_j = \sum_{i=1}^{5} \frac{\beta_i P_{1j}}{\beta_1 P_{ij}} X^*_{1j}$$

and

$$(7)\quad C_j = \sum_{i=1}^{5} P_{ij} X_{ij}.$$

Then this proportion where observed costs exceed the minimum costs for observed output $\left(\frac{C_j}{C^*_j} - 1\right)$ may simply denote an index of cost inefficiency due to cost minimization error in input mix.

As a basis for evaluation of the degree of efficiency in production, the model provides an alternative to the profit maximization problem (Hopper, p. 611; Massell, p. 496). It focuses instead on the cost minimization problem which conveniently allows for examination of several hypotheses related to the effect of education on allocative efficiency of farm operators. Thus, when the standard assumption of perfect and costless information is relaxed and production occurs in a dynamic economic setting where new technology is being generated, the standard first-order conditions for cost minimization may not be fulfilled. Here, a factor can contribute to production by reducing the size of the errors.

The hypothesis is that farm operators who are more efficient at acquiring and processing information will, on balance, be more successful at minimizing cost. Hence, as public research activities perform both basic and applied research, they create disequilibrium in modern farming. This disequilibrium yields excessive costs (losses in profits) and produces incentives for decision makers to learn and adjust their activities. If education enhances the managerial ability of the operator, its productivity becomes a vital source to the decision-making process in agricultural production.

Table 2 reports the regression results of the influence of education on managerial ability. The dependent variable in each equation is a measure of the squared percentage discrepancy between observed cost and estimated optimum input level where the estimated optimum refers to the value at the imputed cost minimum. Only in equation (3) will the dependent variable denote the inefficiency measure of all material inputs. The dependent variable for each of the equations (4–8), measures cost inefficiency of land, machinery, labor, fertilizer, livestock, and miscellaneous respectively. All indexes are explained by operator education and agricultural research expenditure in the state.

In equation (3) the coefficient on education has a negative sign and a small standard error, while that of research expenditure has the expected sign with t-value slightly greater than one. Regression results of equation (3) confirm the hypothesis that inefficiency indexes for aggregate material inputs are inversely related

Table 2. Factors Affecting $\left(\frac{C_j}{C^*_j} - 1\right)^2$ for Aggregate Material Inputs and for Each Individual Input for U.S. Agriculture, 1964

Regression Number		Education	Research	Intercept	R^2	D_f
3	Aggregate	−1.231 (0.590)	0.0005 (0.0003)	0.133	0.105	36
4	Land	19.084 (9.237)	0.003 (0.006)	−0.653	0.250	36
5	Machinery	−2.127 (1.993)	0.0003 (0.0013)	0.299	0.040	36
6	Labor	−13.442 (7.773)	0.002 (0.005)	1.825	0.107	36
7	Fertilizer	−1.058 (1.273)	0.00001 (0.0008)	0.586	0.035	36
8	Livestock, etc.	−0.795 (0.499)	0.0002 (0.0003)	0.127	0.067	36

Note: Standard errors of coefficients are in parentheses.

to operator education. The results indicate weak support for the effect of state research activity.[11] Also, regression results for each of the material input equations (4–8), except for land,[12] confirm those concluded for the aggregated inefficiency index, particularly the effect of education on allocative efficiency.

Scale Economies: Evidence and Implications of Results

The dichotomy of the role of education includes, in addition to cost minimization, the opportunity loss incurred from not maximizing profits. This may result from failure to produce optimum level of output, which is related in this study to scale adjustment in farm size.

Nearly all estimates of aggregate production functions for U.S. agriculture, including the production estimates in table 1, demonstrate statistically significant returns to scale. Indirect evidence pointing to rapidly expanding average size seems to indicate that a continual readjustment, due to the increasing returns to scale, is occurring.[13] Major developments along the usual trend toward increasing farm size can be noted in table 3. During the period between 1959 and 1964, the number of commercial farms declined by more than 13%, while the average growth in receipts rose by nearly 35%.

If scale economies provide incentives for farm size expansion, forces that result in increasing returns to scale must support the comparative advantage of large farms. Many of the economic benefits—particularly gains in capital productivity—favor large farms since they are more capital-intensive in contrast to small farms. Technical advances have also resulted in cost reduction for additional output, thereby increasing the most profitable level of output for the farm (Schultz 1967, pp. 53–70).

As reported in table 4, the use of fertilizer by commercial farms has more than doubled during the period between 1959 and 1964. This increase along the reported price decline of fertilizer (and expansion of agricultural output) makes large farms, which heavily depend on it,

Table 3. Scale Change in U.S. Agriculture, All Commercial Farms

	1959	1964
Number of farms (millions)	3.7	3.2
Gross receipts per farm (1957–59$)[a]	$10,220	$13,780
Decline in number of farms (%)	13.3	
Average growth in receipts per farm (%)	34.4	

Sources: Madden (table 2), U.S. Dep. of Commerce (1961, 1966).
[a] The price deflator is the USDA index of prices received by farmers.

[11] In this study, since the intent is to measure the impact of education on managerial ability, effective education is approximated by the proportion of farm operators who have attended college.

[12] Inconsistent statistical results for the land input should not be surprising, since land input involves large measurement errors. Also, a large portion of the input is fixed, obscuring the influence of the variability of education, or research, or both.

[13] In accounting for growth in measured agricultural activity from 1940 to 1960, Griliches attributes more than one-half of the total gain to growth in size alongside scale economies (1963).

Table 4. Selected Expenses, Unit Cost, Efficiency by Farm Class in United States

			Economic Class of Commercial Farms					
	Date	All Commercial	I (large)	II	III	IV	V	VI (small)
Input per output	1960		0.91	0.95	1.10	1.34	1.69	2.67
(unit cost, $)	1965		0.87	0.89	1.09	1.38	1.87	3.28
Output per input	1960		1.10	1.05	0.91	0.74	0.59	0.37
(efficiency, $)	1965		1.15	1.12	0.91	0.72	0.53	0.30
Percentage share	1960		24.80	15.50	20.60	16.50	10.00	3.50
of all inputs	1965		33.50	19.10	18.60	11.30	6.20	3.90
Percentage share of	1959	93.40						
selected inputs ($)[a]	1964	94.70						
Fertilizer consumption	1959	1.63						
(tons)	1964	3.01						

Sources: Tweeten (table 1), Madden (table 2.3), U.S. Dep. of Commerce (1961, 1966).
[a] Includes feed, livestock, seed, fertilizer, petroleum products, machine hire, and hired labor.

realize the greatest cost savings (Schultz 1967, pp. 53–70).[14]

The size-efficiency relationships favoring large farms are further reflected in the dollar efficiency and unit cost across the six economic classes. As noted in table 4, the unit cost is nearly three times smaller for 1960 and four times smaller for 1965 in class I than in class VI (small farms). In addition, the dollar efficiency is three times larger for 1960 and nearly four times larger for 1965 in class I than in class VI (for the same comparative classes). Thus, this evidence suggests that price and technical changes have enhanced the comparative advantage of large farms.

Furthermore, as rapid technological changes alter efficiency of agricultural production, they create uncertainty regarding the productive characteristics of the "new things." At a point in time, if measured production costs exclude the cost of acquiring information, a measure of scale effect would be directly related to the flow of the "new things" that render information a valuable input. To the extent that a productive research activity provides new and better inputs and techniques, it contributes to the existence of disequilibrium conditions in modern agriculture. The resulting uncertainty, as well as the anticipation of its occurrence and the need for appropriate responses, create an incentive (demand) for information. As information denotes a decision process in production, the productivity of education (education presumably facilitates learning) becomes a vital source of the decision-making process.

Thus, under technically dynamic conditions, the hypothesis is that growth advantages have been accruing to large farms, which alongside rising operator education, implies scale economies in the use of information (Welch 1975, pp. 19–22). This added dimension of the effect of education on allocative efficiency in an uncertain environment, is considered via the role of agricultural research. The idea is roughly that the higher the research activity within a state, the more rapid the pace of technological change and, on balance, the greater are the opportunities for using allocative skills.

In this context, optimum outputs which are tied to scale economies in the use of information are accruing to farms whose operators have higher levels of education.[15] Several tests of the implications of information hypothesis are reported in table 5. As pointed out, information refers to the decision process, so that return to education can be viewed as a return to the decision maker.

The main test of the basic information hypothesis is reported in column 1 (table 5). The estimated scale coefficient—the logarithmic ratio of revenue to observed cost—is explained by operator education and the state research activity. As expected, both inputs are directly related to the dependent variable, and their coefficients have small standard errors.

The regression results imply scale economies in the use of information, where education facilitates learning and where research

[14] Estimates provided by Welch on the expenditure share of fertilizer in 1959 indicate that for class I farm (large size), fertilizer share increased by 44% relative to average commercial farms, while class VI farm showed a decline of over 40% relative to that average (1975).

[15] Welch reports that "average" schooling for 1964 farm operator increases with farm size (1975).

Table 5. Influence of Education and Research on the Scale Coefficient (col. 1), on Farm Size (col. 2), and on Output Growth per Farm (col. 3) in the United States, 1964

Variable	Regression Results 1	2	3
Education	0.719	4.036	17.609
	(0.294)	(1.216)	(10.342)
Research	0.095	0.163	—
	(0.040)	(0.171)	
Intercept	−0.395	6.242	0.283
R^2	0.325	0.290	0.072
D_f	36	36	37

Note: All variables are in logarithmic forms of their original values. Standard errors of coefficients are in parentheses.

activity provides new and better inputs and techniques. The direct relations of both inputs to the scale coefficient strongly suggest that return to education and state research activity are increasing functions of farm size.[16]

Further evidence of adjustments in farm-size efficiency relationship is indicated by column 2 (table 5) where acres per farm are regressed on education and research activity. Both inputs have the logical sign, but only the coefficient of education has a small standard error.

Finally, to provide a support for the allocative efficiency of education over time, the logarithm of the proportionate increase in output between 1959 and 1964 is explained by operator education, column 3 (table 5). The coefficient of education has the expected sign and the t-ratio is 1.70.

Concluding Remarks

A model developed in this paper provides estimates of errors in production which are related to errors in cost-minimizing input combinations and errors in the expansion of output to the optimal level. These errors are treated as indexes of allocative inefficiency and are then explained by the effect of allocative efficiency of operator education.

The statistical results provide strong support for the basic hypothesis that education enhances allocative efficiency and weak support for the hypothesis that the pace of technological change and marginal efficiency are inversely related. The evidence presented suggests that price and technical changes have enhanced the comparative advantage of large farms and that in a technically dynamic environment, there have been scale economies in the use of information. The partial effect of education and research activity is an important determinant of the scale bias.

The actual resource wastage implied by the estimates of this study (almost 10%) suggests that the importance of allocative efficiency and the scope for resource adjustment would make a relevant guideline for public policy.

Since explanation of the allocative phenomenon relies heavily on the relationship between technical change and the value of information, a large share of the returns to education are tied up with these processes and the resulting chain of economic adjustments. As economic growth becomes increasingly dependent on technical change, it becomes imperative that in the quest for optimal combination of resources and their level, emphasis should be placed on factors complementary to learning, since they are a function of the rate of technical change.

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[16] Analysis by Evenson, based on thirty-nine state experiment stations in the United States, indicates that the marginal returns per research dollar were generally higher in stations with more scientists, more graduate students, higher staff salaries, and higher levels of staff training.

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Economic Class as a Measure of Farmers' Welfare

Donald K. Larson

Special tabulations from Internal Revenue Service provide an opportunity for agricultural economists to show that average income of farm operator families distributed by size of farm business receipts gives a misleading indication of the well-being of farm families. For 1970, the distribution of farm taxpayers by basic income classes varies considerably within, as well as between, farm receipt classes. Thus, a small farm business does not mean that the family has a low income, since many receive income from off-farm sources.

Key words: farm income, off-farm income, economic class, farmers' welfare, tax data.

In the past, it was assumed that farm family income was directly related to the size of farm business. Opportunities to pursue nonfarm businesses and obtain off-farm employment were usually limited. Hence, past public outlays for agriculture were motivated by concern for low returns on invested resources of farm people. Usually, any income derived from off-farm sources was of minor importance to the family. Despite some improvements in depicting the income of farm people for establishing farm policy, visible gaps still exist in our knowledge about their personal income, but we know that off-farm income is now no minor matter.

Low net farm incomes were associated with small farm businesses which formerly implied that family income also was relatively low. But increases in mechanization and technology combined with improved off-farm job opportunities have encouraged many farm people to hinge their economic well-being on a mixture of farm and nonfarm pursuits (Bonnen et al., Hanson and Spitze, Reinsel 1968, 1972, USDA 1970, 1973, U.S. Dep. of Commerce 1973b). Today, a small farm business does not necessarily mean the farm family has a low money income. Therefore, size of farm business is no longer a good indicator of farm family well-being. Yet size of farm business is still used by some policy makers as an indicator of the level of well-being among farm people.

Researchers interested in differentiating between size of farm business and level of family income have found it difficult to obtain data at the national level to base their analysis on. In the following discussion, the relationship between the distribution of total family income and size of farm business receipts is explored using data from the Internal Revenue Service.[1]

Data Sources

Data are from special tabulations provided by the U.S. Department of the Treasury, Internal Revenue Service (IRS). The author did not have access to individual tax records. Provisions for such special statistical studies are made in section 7515 of the Internal Revenue Code.

The IRS data are based on a national probability sample of all individuals reporting earnings from farming activities in 1970. These individuals comprise not only farm operators but all other persons reporting income from farm sources. Farm receipts include sales of livestock, livestock products, crops, government farm program payments, and other taxable farm related income. Off-farm income includes all wages and salaries, interest, dividends, nonfarm business income, royalties,

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[1] Size of farm business receipts is generally referred to in the literature as "value of sales" or "economic class of farms" (U.S. Dep. of Commerce 1973b). These terms will be used synonymously throughout this paper.

rents, ordinary gain or loss on capital assets, and other taxable income. Not included are social security benefits, welfare and other transfer payments, interest on nontaxable bonds, and the value of home-consumed farm products (Reinsel 1972). Because the majority of the tax returns appear to be joint returns, income reported on tax returns for 1970 can be considered essentially the same as total family income.[2]

Before analyzing the IRS data, trends in farm family income based on the *Farm Income Situation (FIS)* (USDA 1973) will be discussed. This national data source is frequently referred to in policy discussions on farm family income but has limited usefulness for this purpose. However, we must remember that the definition of both population and income differs from IRS. Income of farm operator families is the sum of realized net farm income and off-farm income divided by number of farms. Realized net farm income consists of realized gross farm income, including government program payments and nonmoney income, minus all farm production expenses. To this is added estimates of income derived off the operator's farm. Included are wages and salaries, nonfarm business income, rental of nonfarm property, dividends, interest, royalties, social security payments, retirement benefits, and income from other sources.

[2] Federal income tax data have certain limitations. The reader is referred to two articles which adequately cover the major limitations (Reinsel 1968, 1972).

Farm Family Income via *FIS*

Off-farm income among farm operator families rose three times as fast during the 1960s as did realized net farm income. Realized net farm income increased from $11.7 billion in 1960 to $16.8 billion in 1970 or a 44% increase. For this same period, off-farm income rose from about $8.5 to $17.1 billion or 101%. In 1960, off-farm income was 42% of total income per farm operator family. By 1970, it was about 51%.

Families living on small farms, farms with less than $5,000 of marketings in 1970, averaged nearly 64% more from off-farm income than those with $5,000 or more of sales (fig. 1). This is not surprising because, in general,

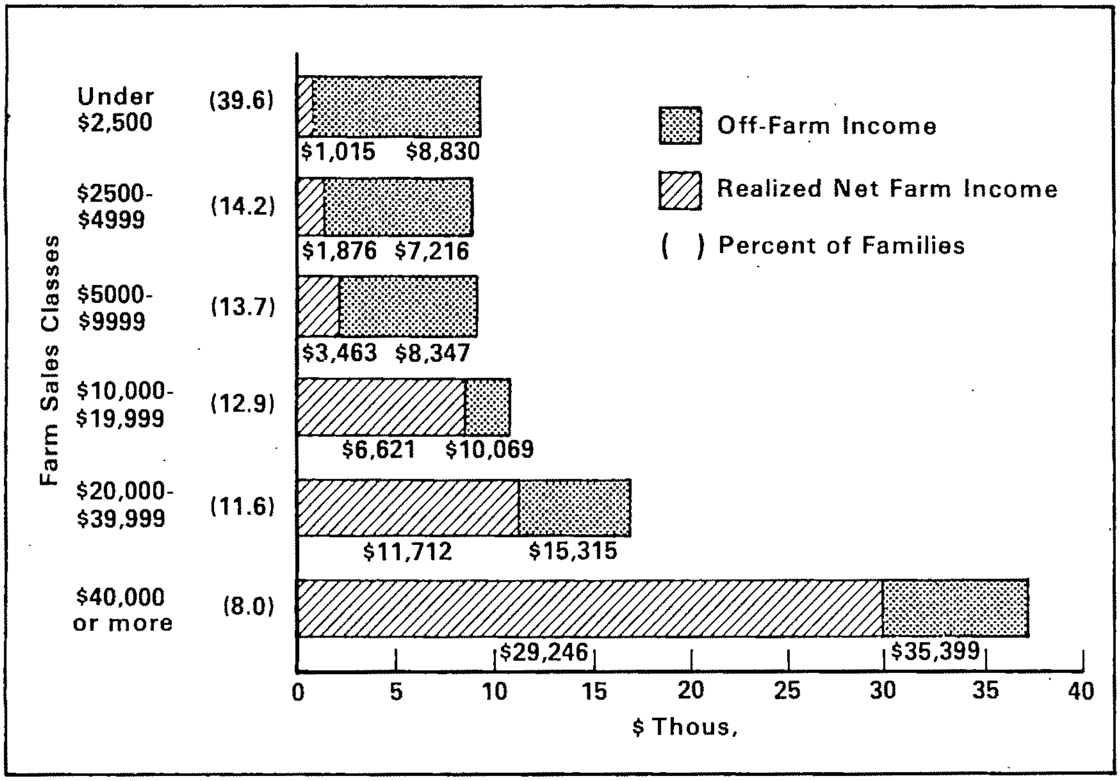

Figure 1. Income per farm operator family by farm sales classes, 1970. Source: USDA 1973.

larger farms use more of the family's labor resources. An operator with a small farm, however, needs additional income and generally more time for other jobs. However, families with relatively large farms, $40,000 or more of sales, also have relatively high off-farm income—about 17% of average total income from all sources.

Distributing average family income by farm size classes hides the existence of low income farm families. True, families living on small farms, e.g., those with less than $5,000 in farm product sales, have low net farm incomes. But, the addition of $7,200 average off-farm income in 1970 clearly lifts these families as a group out of a low income status. Thus, without information on the underlying personal income distributions within each size class, one could infer that few farm families had low money incomes. Averages can be misleading when differences in incomes are known to exist within farm size classes. What we need is the personal distribution of incomes before analyzing the well-being of farm families.

The methods used to estimate the averages presented in the *FIS* preclude looking at the underlying distributions of total family income. However, special tabulations prepared by IRS on sole proprietors reporting farm income in 1970 provide an opportunity to explore these underlying distributions. An assessment of possible farm losses and their impact on the underlying distributions can be made.

Farm Family Income via IRS

Over 2.8 million persons reported farm earnings for tax purposes in 1970, and their average net farm and off-farm income by economic class of farm is the starting point for this discussion (table 1). Several factors cause these averages to differ considerably from those presented in figure 1. Slight differences in the populations account for some of the discrepancy. Also, 1.2 million or 42% of the farm taxpayers reported farm losses totaling $2.8

Table 1. Income by Persons Reporting Farm Earnings, 1970

		Value of Farm Sales							
	Unit	Less than $2,500	$2,500–$4,999	$5,000–$9,999	$10,000–$19,999	$20,000–$39,999	$40,000–$99,999	$100,000 or more	All Farm Sales Classes
All returns									
Returns	1,000	1,217	407	392	379	275	132	33	2,840
Basic income[a]	$	9,310	6,940	7,050	7,570	9,800	13,380	24,210	8,830
Net farm income	$	-690	-760	780	2,480	4,650	6,510	6,810	970
Off-farm income[b]	$	10,480	7,720	7,070	5,750	5,810	7,780	18,880	8,550
With off-farm income	%	94.6	91.7	88.6	86.8	88.7	89.2	89.5	91.9
With a net farm loss	%	62.5	40.1	30.9	22.0	16.2	18.3	27.3	42.5
Returns with farm profits									
Returns	1,000	457	244	271	297	231	108	24	1,632
Basic income[a]	$	7,130	6,090	6,650	7,730	10,150	14,280	24,480	8,160
Net farm income	$	710	1,320	2,340	4,200	6,640	10,140	18,070	3,420
Off-farm income[b]	$	7,180	5,520	5,010	3,990	3,960	4,700	7,210	5,380
With off-farm income	%	88.1	88.7	86.2	85.8	88.4	88.6	87.9	88.1
Returns with farm losses									
Returns	1,000	760	163	121	82	44	24	9	1,208
Basic income[a]	$	10,620	8,210	7,930	7,010	7,970	9,340	23,500	9,740
Net farm income	$	−1,530	−2,070	−2,720	−3,730	−5,810	−9,820	−23,210	−2,350
Off-farm income[b]	$	12,280	10,650	11,280	11,870	15,190	20,640	49,730	12,450
With off-farm income	%	98.5	96.3	94.2	90.2	90.5	91.7	93.9	97.1

Source: U.S. Dep. of the Treasury.
[a] Basic income is defined as adjusted gross income plus excluded capital gains, dividends, and other adjustments to income.
[b] Amounts are based on those reporting.

billion in 1970. About three-fourths of the loss returns were from small farms—those with farm sales less than $5,000. Small farms were more likely to report a loss than large farms. Thus, a negative net farm income occurred in the two lower farm sales classes. One must also remember that individuals tend to minimize reported income for tax purposes.[3] Despite these shortcomings, the IRS data can still provide an indication of the usefulness of economic class of farm as a welfare measure.

In this study, basic income, a relatively new concept, is used as the distributor. Basic income approximates the income farm taxpayers had available from both farm and off-farm sources during the year for family living expenditures, payment of taxes, and investment.[4]

The frequency distributions of farm taxpayers by basic income classes within farm sales categories are skewed far to the right (table 2). The significance of these distributions is their lack of uniformity between farm sales classes and between persons reporting farm profits and losses. Consider first the distributions of those reporting farm profits (table 2). The distribution of persons with farm sales less than $2,500 is highly skewed to the right. About 52% of these persons had a basic income below $5,000 in 1970. In contrast, 17% of those with farm sales of $40,000–$99,999 had a basic income of less than $5,000. Their distribution, however, is not exactly the same shape as that of other distributions within farm sales classes.[5]

The distributions of taxpayers reporting farm losses by basic income classes differ considerably from the distributions for those who reported farm profits in 1970 (table 2). For those reporting losses and $20,000 or more in farm sales, their distribution is J-shaped. Their J-shaped distribution stems from a high proportion who reported a negative basic income. Most significant is the increased concentration of persons with less than $5,000 basic income as farm sales increased. This tendency among taxpayers reporting farm losses is opposite to that found among those reporting farm profits.

Farm income was not the only or even primary source of income for many farm taxpayers. In 1970, about 61% of the farm taxpayers reported wage and salary income. Some 12% reported a nonfarm business profit or loss, and others reported income from partnerships, dividends, interest, and other taxable earning sources. (Similar results are found in the two reports by Reinsel.) The relative importance between farm and off-farm earnings is, however, more clearly portrayed through those reporting farm profits.

In 1970, farm profits were reported by 1.6 million persons whose total basic income equaled $13.3 billion of which $5.6 billion constituted net farm profits. Off-farm income totaling $7.7 billion, nearly 38% more than net farm profits, was reported by 88% of these persons. Close to 50% of the farm profit returns had both farm sales and basic incomes below $10,000. Nearly 24% had farm sales and basic income below $5,000. Only 6% of these persons had a basic income of $20,000 or more in 1970.

Income from farming was the principal source for 61% of those persons reporting farm profits in 1970—those persons falling into the classes above and to the right of line in table 3.[6] For those with income from farming as a principal source, over half or 56% had a basic income below $5,000 in 1970. It appears that many who had less than $5,000 in basic income may be in need of income support. However, this need was lower among those dependent on off-farm earnings as their primary source—those in the classes below and to the left of the line in table 3. Less than one-third of those persons who reported a farm profit but primarily relied on off-farm income had a basic income below $5,000 in 1970. Yet, farm income was a relatively minor source for all persons with a basic income of $100,000 or more in 1970 (table 3). Probably all with $100,000 or more in basic income would not be considered as farmers in the traditional sense. Information in table 3 reflects the mixture of part-time and full-time farm operators found within the food and fiber production sector

[3] Results in this study, along with findings by Carlin and Woods, suggest that "tax loss" farming is not a typical activity in the U.S. food and fiber production sector. Only 0.6% of the farm loss returns had an average farm loss above $20,000 in 1970. While some farm losses may have been generated to offset off-farm income, thereby reducing total tax liability, all farm losses in this study were counted as an economic loss.

[4] Basic income is defined as nonexempt taxable income plus excluded capital gains, dividends, and other adjustments to income such as sick pay, moving expenses, employees' business expenses, and payments to retirement by self-employed persons. Not all income available for these purposes is included, since nontaxable income was excluded (Carlin and Woods).

[5] Neighboring distributions tend to be highly correlated. But, for example, the distribution of persons with profit returns and less than $2,500 in farm sales has a low correlation with those with farm sales of $100,000.

[6] Those above and to the right of the solid line reported that income from farming was more than half their total family income.

Table 2. Distribution of Income by Persons Reporting Farm Earnings, 1970

	Number of Returns	Basic Income Classes												
		Negative Basic Income	$1–$2,499	$2,500–$4,999	$5,000–$7,499	$7,500–$9,999	$10,000–$12,499	$12,500–$14,999	$15,000–$19,999	$20,000–$24,999	$25,000–$49,999	$50,000–$99,999	$100,000 or more
	1,000	%											
Farm profit returns	1,632	0.5	21.2	21.3	17.1	13.4	9.2	5.8	5.6	2.5	2.7	0.5	0.1
Value of farm sales:													
Less than $2,500	457	0.5	33.9	17.9	12.6	11.0	9.2	6.0	4.7	1.9	1.9	0.5	0.1
$2,500–$4,999	244	0.6	33.9	23.8	14.4	11.0	6.0	3.5	3.3	1.4	1.7	0.3	0.1
$5,000–$9,999	271	0.5	20.6	31.8	18.5	11.5	6.9	3.2	3.7	1.3	1.5	0.3	0.1
$10,000–$19,999	297	0.6	10.4	25.2	25.7	16.5	9.0	4.9	4.1	1.6	1.5	0.3	0.1
$20,000–$39,999	232	0.3	6.6	14.6	19.4	19.5	14.1	9.8	8.8	3.4	2.9	0.4	0.1
$40,000–$99,999	107	0.9	5.0	11.1	12.0	12.7	12.3	10.6	15.6	8.4	9.9	1.0	0.2
$100,000 or more	24	1.7	3.2	7.1	9.2	10.3	7.8	7.0	10.8	11.3	21.7	8.0	2.0
Farm loss returns	1,208	10.0	12.8	15.0	16.2	14.9	10.5	6.4	6.6	2.4	3.4	1.3	0.5
Value of farm sales:													
Less than $2,500	761	3.5	11.4	15.0	16.9	16.9	12.5	7.7	8.1	2.7	3.7	1.2	0.4
$2,500–$4,999	164	12.3	14.5	18.3	16.2	14.5	8.5	5.5	4.7	1.6	2.4	1.0	0.4
$5,000–$9,999	121	17.3	16.1	14.7	18.5	11.7	6.8	4.8	3.9	2.4	2.2	1.1	0.5
$10,000–$19,999	84	27.7	17.6	13.7	12.4	9.2	6.3	2.4	4.4	1.5	2.9	1.1	0.7
$20,000–$39,999	45	36.3	14.9	9.8	9.8	9.0	5.1	2.8	3.5	2.0	3.4	2.1	1.3
$40,000–$99,999	24	41.7	10.0	11.3	8.0	4.6	5.6	3.4	2.6	2.2	5.7	2.7	1.8
$100,000 or more	9	42.5	6.0	8.5	8.2	5.4	3.9	3.7	3.3	2.0	7.2	5.3	4.1

Source: U.S. Dep. of the Treasury.

Table 3. Net Farm Income as a Percentage of Basic Income by Persons Reporting Farm Profits, 1970

	Value of Farm Sales						
Basic Income	Less than $2,500	$2,500–$4,999	$5,000–$9,999	$10,000–$19,999	$20,000–$39,999	$40,000–$99,999	$100,000 or more
				%			
Negative	a	a	a	a	a	a	a
$1–$2,499	51.9	68.9	71.3	80.3	89.7	a	a
$2,500–$4,999	18.7	45.1	64.3	72.3	73.2	80.0	a
$5,000–$7,499	11.5	24.4	49.1	67.2	73.6	78.9	76.5
$7,500–$9,999	7.4	14.6	29.1	61.4	73.2	74.5	84.6
$10,000–$12,499	5.4	12.5	22.4	52.7	71.0	72.9	78.0
$12,500–$14,999	4.6	8.6	19.4	44.5	67.8	76.9	92.8
$15,000–$19,999	5.9	9.0	17.2	43.2	65.9	74.8	81.4
$20,000–$24,999	5.3	6.9	20.4	33.8	62.6	76.7	73.2
$25,000–$49,999	4.0	6.7	12.8	20.8	44.1	69.0	79.5
$50,000–$99,999	2.7	3.8	5.7	9.7	17.2	43.6	72.0
$100,000 or more	3.0	1.9	1.7	4.3	6.0	6.5	29.7

Source: U.S. Dep. of the Treasury.
[a] Off-farm earnings were negative and greater than net farm earnings.

(U.S. Dep. of Commerce 1972, 1973a). Thus, size of farm business may not be a good indicator of what constitutes a part-time farm.

Some sole proprietors reporting profits with a large farm business in 1970 fell into the low end of the basic income distribution. Low net farm profits plus net losses from nonfarm businesses, partnerships, and other off-farm earnings were the primary factor. Unprofitable off-farm ventures may have been used by some to offset farm profits and thereby reduce total tax liability. However, the proportion was small among large farm businesses, $40,000 or more in farm sales, that reported a farm profit and off-farm losses—about 1% of all profit returns.

Off-farm income was quite important to those persons reporting farm losses. It would be interesting to speculate on why persons had farm losses in 1970 (see Reinsel 1968, pp. 11–12). Without off-farm income, many persons could not sustain losses over an extended period of time. Thus, it is not surprising that average off-farm earnings were more than twice as large among those reporting farm losses as those reporting farm profits in 1970.

Implications

The underlying distributions of total family income by economic class indicate that a wide range of family incomes exists within each size of farm business. The differences in average basic incomes between basic income classes are highly significant based on the data presented. A small farm business does not mean that a family has a low income. Nor does a large farm business guarantee that a family will have a high income. Thus, size of farm business does not accurately reflect the income situation of farm people.

Data such as those from IRS help researchers to demonstrate that the notion of farm family income being closely tied to size of farm business is no longer valid. The number of persons dependent upon farming as a primary source of income is now a relatively small proportion of all people with farm earnings. A significant change in the economic conditions in the farming sector may mean only a minor change in income of many people engaged in farming.

Policy makers who provide assistance to farm families should definitely recognize the relative importance of off-farm earnings. Because so many farm people have combined farming with a nonfarm job, their economic well-being is now more closely linked to economic conditions in the nonfarm sector. Thus, not only is farm policy important to people with farm income, but public policies designed primarily to affect the nonfarm sectors may be of equal or greater importance.

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Measurement of the Economic Efficiency of Central-Fabrication- versus Carcass-Meat-Handling Systems

C. W. O'Connor and T. M. Hammonds

Relative economic efficiency is measured for a selected sample of retail meat departments using the UOP (unit output price) profit model developed by Lau and Yotopoulos. The analysis suggests that central fabrication is currently more efficient for some, but not all, independent retail meat departments. The analysis also suggests that the relatively new UOP profit model is superior to the more traditional Farrell linear programming technique for evaluating relative efficiency.

Key words: efficiency, frontier functions, profit functions, beef, retail meat.

Centralized cutting of beef is receiving considerable attention from the retail meat industry. This is partly a consequence of the recent pressure on retail stores to reduce their marketing margins and partly a consequence of improvements in the technology of preserving the quality of centrally fabricated meat. Fabrication offers the potential for a gain in marketing efficiency primarily through more efficient use of labor, more efficient use of by-products, and lower transportation costs.[1]

Various fabrication systems have been subject to considerable analysis of a technical or physical efficiency nature (Hoecker; Kearney; Weatherly, Earle, and Brown; Erickson and Litchty). No analysis has been published of the pricing or economic efficiency of fabricated- versus carcass-handling systems. This is perhaps a natural consequence of the meat industry's tendency to think in terms of gross product volume and gross sales while neglecting net profit data. This study compares the relative technical, pricing, and economic efficiency of retail meat departments using centrally fabricated meat with departments using the traditional carcass-handling system.

Fabricated meat goes by a variety of names including boxed meat, saw-ready meat, and block-ready meat. All of these systems move the breaking of carcass beef out of the supermarket to a centralized cutting point. Meat is shipped to retail stores in primal and subprimal form although some processors actually ship consumer cuts. This represents the first major technological change in retail meat handling since the 1920s and seems to be gaining momentum. By 1969 there appeared to be a marked trend in this direction, and today over one-half of the beef shipped to supermarkets is centrally prefabricated. A 1973 survey by the National Association of Food Chains indicates that by 1977 supermarkets will receive 65% of their fresh meat in primal and subprimal form, 15% in consumer cuts, and only 20% in carcass form (Shaw and Christensen). However, not all firms which have adopted the new system have improved their efficiency or their profits. It is time for a systematic evaluation of relative efficiency.

Retail Meat Systems

With the advent of the supermarket, the butcher shop was replaced with retail meat departments selling cellophane-wrapped packages. The advantages of greater volume and expanded shelf life made this an agreeable change for both retailer and consumer. At the same time, new assembly line cutting techniques were developed to improve handling efficiency. This same general concept of

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[1] Fabricated cuts are primals (those parts of a carcass commonly separated) which have been trimmed such that a minimum of cutting and handling at the retail store is necessary to produce consumer cuts.

meat preparation and merchandising still characterizes the retail segment of the industry today.

All red meats do not move through the marketing channels in the same form. The hog-pork sector sells approximately one-half of its retail meat in cured or processed form. Beef, on the other hand, is sold almost entirely as fresh meat with approximately one-half delivered to the retailer in carcass form (Shaw and Christensen). The change from carcass to fabricated beef is more subtle from the consumer's point of view than was the change from butcher shop to supermarket. In fact, the consumer may be entirely unaware of change since the retail cuts will be the same under both systems. The primary advantage to fabrication is a gain in efficiency or, alternately, lower production costs.

A priori, several characteristics of carcass systems seem to encourage change. First, each carcass must be handled a number of times at each distribution point. However, the carcass is hardly of a form or weight to be handled easily. Second, the entire cutting operation takes place at the retail market. A small weight loss due to shrinkage occurs at the packing plant, but a massive weight loss resulting from trim and waste occurs in the retail store. Transportation and refrigeration costs are increased significantly by this system. In addition, carcass trim is often reshipped to a central location for use in products such as sausage, pizza sauces, etc. Third, levels of meat processing in retail stores tend to be limited by local sales volume rather than by the efficient utilization of space, labor, and capital investment. The result has been chronic overcapacity in the retail meat department. Fourth, when the retailer handles carcass beef he is committed to market all of the resulting cuts. This prevents regional redistribution of retail cuts for better conformity with local or ethnic purchasing preferences.

While a central fabrication system probably would improve beef-marketing efficiency in the aggregate, there is wide variation in the profitability of individual retail meat departments. One would suspect that not all retailers would benefit uniformly from such a change and that some might fail to benefit at all.

Sample Stores

Promoters of the various fabrication systems are currently approaching retail store owner-operators and managers on a nationwide scale. Therefore, the economic unit selected for this study was the retail meat department. The sample was drawn from the major metropolitan areas of Oregon and Washington.

There are three basic handling systems readily discernible in the sample areas: the traditional naked carcass system, the newer fabricated system, and the frozen meat distribution system. Frozen meat is being used primarily by low-volume outlets in rural areas and is showing little growth. It will not be pursued here because of its limited clientele. Interested readers will find a descriptive study of frozen beef retailing in an earlier report (Youde and O'Connor).

In general, Oregon has remained with the traditional naked carcass distribution system while retailers in the state of Washington have adopted the fabricated system. This provides an excellent opportunity for stratification of the sample. Each of the major metropolitan areas studied have a different technology and are not in a state of transition with respect to their particular system. This is important since the body of the theory used is intended to measure the relative efficiency of stabilized technologies, not the diffusion of technological change.

In designing the sampling plan, three difficulties common to studies of this type were encountered. First, since this is a highly competitive industry, many retailers would not release data on the profitability of their individual stores. Second, detailed profit-loss statements are not typically kept for individual meat departments. Third, governmental intervention (the 1973 retail price freeze) artificially distorted some of the available data.

Cooperation was obtained from forty-two individual store managers after a series of meetings with industry personnel. Since the profitability of individual meat departments is not routinely summarized, data were collected directly from store records. Invoices of all meat purchases, sales records, meat department labor utilization, and an accurate description of all equipment in the meat department were collected for each sample store for the month of February 1973. This time period was selected for three basic reasons. First, the federal retail price freeze that existed through most of 1973 had not yet been put into effect. Second, February meat sales historically have exhibited little seasonal sales variation. This may be attributed to the fact that no "eating" holidays exist in February. Third, industry

representatives felt that this period would minimize any differences between beginning and ending inventories.

Composite retail prices for beef, pork, poultry, and lamb for the Portland and Seattle survey areas are shown in table 1. The retail price level for the survey stores was slightly higher for beef and pork in the Seattle area and equal for poultry and lamb.

The measurement of capital assets in a cross-section survey presents some conceptual and operational difficulties. Conceptually, only the service flow from fixed capital should be considered as an input for a given production period. However, in practice, the value of the stock of capital has often been used as a proxy for the service flow. Yotopoulos points out the fallacy of using the capital stock or, alternatively, of applying a simple depreciation rate to approximate the service flow. He goes on to develop a more appropriate service proxy which was utilized in this study.[2]

The capital requirements for meat departments using the carcass- and fabricated-meat-handling systems are virtually identical. The primary equipment savings occurs at the central fabricating level. The only in-store capital cost that could be eliminated in a fabricated system is the overhead carcass rail. This rail costs approximately $12.50 per linear foot and, in most stores, would total about $1,000 as of early 1973. Because of this small cost, most stores setting up to handle fabricated meat will add rails to retain the flexibility of handling carcass beef.

The meat department inputs for this study are wholesale meat, labor, and a service flow of capital. The output is retail meat composed of beef, pork, lamb, and poultry. The departments were originally stratified into small-, medium-, and large-volume categories based on average weekly meat sales. However, the small-volume group exhibited extreme variability in calculated profits. In fact, a high proportion of this group (average weekly meat sales of less than $4,000) had negative profits. Because of this variability and the inability of the logarithmic UOP (unit output price) profit model to handle negative numbers, the small category was eliminated. This left a sample size of thirty-two, composed of seventeen medium-volume (average weekly meat sales of $4,000–$10,000) and fifteen large-volume (average weekly meat sales in excess of $10,000) departments. A larger sample would, of course, have been preferable. However, the numbers were limited by management reluctance to release data in the detail required.

This final sample was homoskedastic with respect to size. It was decided a priori that size would be an important variable to examine as a potential determinant of performance. It was, therefore, desirable to have the sample homoskedastic with respect to this variable to allow both medium and large departments to be included in the same regression equation.

Table 1. Weighted Average Retail Prices for All Sample Stores, Feb. 1973

	Price per Pound	
	Portland	Seattle
	(carcass system)	(fabricated system)
Beef	$1.15	$1.29
Pork	1.20	1.34
Poultry	0.59	0.59
Lamb	1.28	1.28

Measuring Efficiency

Since Farrell's series of articles in the late 1950s–early 1960s, the most generally accepted method for examining efficiency in the literature of agricultural economics has been the linear programming approach. Therefore, it is appropriate to compare the performance of this approach with the more recent UOP profit model. To our knowledge, no published research compares the two techniques using the same data set.

The Farrell-Fieldhouse model, which incorporates scale of operation, was selected as the programming model. This model estimates the efficient unit isosurface (EUIS) which is, in this case, an approximation of the production function for the handling of meat products in a retail store. By definition, this surface defines the minimum input-output ratios for alternative combinations of inputs and scales of operation. The level of technical efficiency estimated for each firm is a function of the

[2] The service flow of capital was estimated using

$$\bar{R} = \frac{r\,V_0^T}{1 - e^{-rT}}$$

where $\bar{R}$ = constant service flow, V_0^T = present value of a new asset with a useful life of T years, and r = discount rate selected. The service flow is obtained by solving the present value formula for an annuity under continuous discounting. Users should note that there is an error in the original article which omits the negative sign in the exponent of the denominator.

relative distance from the axis to the EUIS and from the axis to the point representing the individual firm. Firms which lie on the efficient isosurface are judged most technically efficient, those using the smallest amount of inputs per unit of output, and have a technical efficiency coefficient of 1.0. Firms which lie inside this isoquant have an efficiency coefficient of less than 1.0. The overall shape of the EUIS is determined by the state of knowledge within the industry and the implementation of that knowledge within the distribution channel.

Price efficiency is estimated with the incorporation of an isocost surface. Firms operating at the intersection of the EUIS and the isocost surface are judged most price efficient, those using their resources in the correct proportions, and have a price efficiency coefficient of 1.0. Total economic efficiency is expressed as a product of the technical and pricing efficiencies (see Farrell; Farrell and Fieldhouse; Seitz for details).

The UOP profit model proceeds along a different tack. Observing that different firms producing roughly homogeneous outputs may do so with differing factor intensities if they face differing input-output prices, Lau and Yotopoulos develop a model incorporating both input- and output-price levels. Their model consists of a single profit equation, expressing the profit level as a function of fixed input quantities and variable input prices normalized in terms of the unit output price plus a series of equations expressing the derived demand function for each variable input. Each equation may be estimated by ordinary least squares since all independent variables (normalized variable input prices and fixed input quantities) are determined exogenously for price-taking firms. McFadden proves that every concave production function has by duality a convex production function and vice versa. Therefore, the analysis may proceed in terms of UOP profit model without the necessity of estimating the underlying production function if the firms are profit maximizers and price takers.

Given the basic character of both approaches, the UOP profit model appears the more attractive from several theoretical points of view. The UOP model is estimated by ordinary least squares and therefore provides the standard statistical measures of goodness-of-fit. The Farrell approach generates its parameter estimates through linear programming with none of these statistical measures available. The UOP model is less sensitive to outliers than is the pessimistic isoquant generated by the Farrell model. And the UOP model gives full consideration to relative prices, while the Farrell model proceeds in the complete absence of output-price data.

Table 2 presents the estimated Farrell technical-efficiency ratings for the thirty-two sample stores, and table 3 presents the estimated pricing-efficiency ratings. For both types of efficiency, the performance of carcass-system departments is more variable than than the performance of fabricated-system departments.

However, the ratings are not useful beyond this preliminary observation in testing relative efficiencies since a basic assumption of the model is violated. The Farrell-Fieldhouse model assumes a neutral shift in the production function which occurs as the result of a new technology. If this assumption is vio-

Table 2. Technical-Efficiency Ratings for Thirty-Two Retail Meat Departments

Efficiency Rating	Medium-Sized Carcass	Medium-Sized Fabricated	Large-Sized Carcass	Large-Sized Fabricated	Total Number of Firms
1.000	3	6	3	5	17
0.999		1		1	2
0.997		3			3
0.994				1	1
0.933				1	1
0.979			1		1
0.969			1		1
0.965			1		1
0.960	1				1
0.948	1				1
0.938	1				1
0.932	1				1
0.916					1

Table 3. Pricing-Efficiency Ratings for Thirty-Two Retail Meat Departments

Efficiency Rating	Medium-Sized Carcass	Medium-Sized Fabricated	Large-Sized Carcass	Large-Sized Fabricated	Total Number of Firms
1.000		3		2	5
0.999		1			1
0.998	1	2			3
0.992	1				1
0.938		2		1	3
0.930				1	1
0.977			1		1
0.975			1		1
0.974		1			1
0.973				1	1
0.971		1			1
0.969				1	1
0.963				1	1
0.961				1	1
0.957	1		1		2
0.953	2				2
0.949			1		1
0.943			1		1
0.934			1		1
0.938	1				1
0.933			1		1
0.926	1				1

lated, a variety of possibilities arise. First, the production functions for the two technologies may be nonintersecting but differ from one another in a nonneutral fashion, that is, the new technology may favor one input over the others. If this is the case, firms utilizing the different technologies would employ different factor mixes even if they faced the same set of factor price ratios. The Farrell-Fieldhouse efficiency ratings would not reflect this type of behavior and would, therefore, incorrectly assess relative efficiencies. Second, the production functions may be intersecting. If this is the case, relative efficiency would change with changes in factor price ratios and a general statement of relative efficiencies could not be made. Third, the firms may cluster themselves such that the linear programming model estimates a production function which represents neither technology uniquely (i.e., a misspecified function which represents a mixture of the two individual functions). If this is the case, the measures of relative efficiency developed from the mongrel production function will be of no value.

The Farrell-Fieldhouse model has not estimated a production function which differs between the two technologies in a neutral fashion. Both carcass-system departments and fabricated-system departments appear on the EUIS with technical efficiency ratings of 1.0. A neutral shift would cause users of only one of the technologies to appear on the EUIS. We must, therefore, conclude that the ratings in tables 2 and 3 cannot be used for testing relative efficiency.

Even if the model had not assigned both technologies an efficiency of 1.0, we would not be able to confirm that the two production functions differ in a neutral fashion. The lack of a direct test for this critical assumption is a serious flaw which should be kept in mind when examining the UOP profit model.

An alternative procedure to attempt a resolution of this difficulty would be to further disaggregate the data. Relative efficiency measures could be developed separately for the two technologies within each size category. The limited sample size for this study made further disaggregation unattractive.

One further difficulty in dealing with the Farrell model should be noted. All firms which lie inside the EUIS are evaluated relative to firms which lie on this surface. The surface itself is formed by a series of arcs connecting the most efficient firms. At the extremes of the surface, the line turns parallel to the input axis and extends to infinity. Figure 1 illustrates such a surface in two dimensions. Firms a, b, c, and d define the efficient isoquant illustrated. Consider firms X and Y, both inside the isoquant. The technical effi-

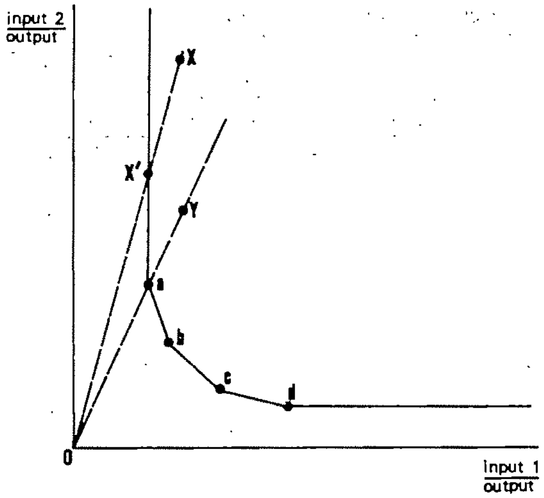

Figure 1. Efficient unit isosurface for the Farrell model

ciency of X may be defined as (OX'/OX) 100 which is exactly the same as the technical efficiency of firm Y defined as (Oa/OY) 100. Yet we know that firm Y utilizes (X − Y) less of input 2 than does firm X. The technical efficiency of firm X is biased when calculated in this fashion.

Bressler discusses this phenomenon noting that a bias exists for all firms falling within the cones defined by the sections of the isosurface parallel to the input axes and rays from the origin extending through the most extreme observations on the surface. "Our empirical studies suggest that a surprisingly large proportion of observations involve [this phenomenon]" (p. 133). Of the thirty-two firms included in this analysis, twenty-three fell into these cones. Thirteen of the twenty-three were departments using carcass-handling systems and ten were departments using fabricated-handling systems. Technical efficiency is, therefore, biased for approximately 72% of the sample.

The analysis now proceeds to the UOP profit model and relative efficiency tests as derived by Lau and Yotopoulos (1971, 1972). Following their derivation, the specific profit equation for this study becomes

$$(1) \quad \ln \pi_j = \ln A + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_1 D_2 + \alpha_1 \ln c_1 + \alpha_2 \ln c_2 + \beta_4 \ln K + \ln v,$$

where π_j = the UOP profit for the jth firm; A = intercept value; D_1 = 1 for large-volume departments, 0 otherwise; D_2 = 1 for fabricated handling systems, 0 otherwise; c_1 = normalized wholesale meat price; c_2 = normalized wage rate; and K = service flow of fixed capital inputs.

The specific derived input demand relations are

$$(2) \quad \frac{-c_1 X_1}{\pi_j} = \alpha_3 + \beta'_1 D_1 + \beta'_2 D_2 + \beta'_3 D_1 D_2 + v'$$

and

$$(3) \quad \frac{-c_2 X_2}{\pi_j} = \alpha_4 + \beta''_1 D_1 + \beta''_2 D_2 + \beta''_3 D_1 D_2 + v'',$$

where X_1 = the pounds of wholesale meat purchased by the jth firm, and X_2 = the man-hours of labor employed by the jth firm.

The parameter estimates for these equations appear in table 4.

As in the Farrell model, this specification implies that the underlying production functions for both technologies are identical up to a neutral efficiency parameter. However, in this case, a specific test of the assumption may be carried out by investigating the stability of the coefficients of $\ln c_1$, $\ln c_2$, and $\ln K$ across the four departmental groupings. This hypothesis was tested by estimating separate equations for each group and applying a test for the constancy of coefficients for meat, labor, and capital as suggested by Huang (pp.

Table 4. UOP Profit Model Parameter Estimates

Equation	Parameter	Estimate and t-Statistic[a]	
(1)	$\ln A$	4.742	(0.69)
	β_1	1.298	(4.85)
	β_2	0.521	(1.18)
	β_3	−0.950	(2.95)
	α_1	−4.343	(1.03)
	α_2	−4.011	(1.35)
	β_4	1.117	(1.92)
$R^2 = 0.827$		$F(6,25) =$	19.971
(2)	α_3	−19.787	(9.83)
	β'_1	12.338	(4.33)
	β'_2	13.994	(5.33)
	β'_3	−11.277	(2.96)
$R^2 = 0.576$		$F(3,28) =$	12.695
(3)	α_4	−3.856	(8.89)
	β''_1	2.815	(4.59)
	β''_2	2.901	(5.13)
	β''_3	−2.473	(3.01)
$R^2 = 0.573$		$F(3,28) =$	12.539

[a] No significant multicollinearity was found in these equations.

112–16). The computed F-value for this test was 0.69 versus a critical value of F (9,16) = 2.54. We may accept the hypothesis that α_1, α_2, and β_4 do not differ across these departmental groupings and that, therefore, the neutrality assumption is justified.

That this model survived the neutrality test is of interest. But of greater interest is that the UOP profit model provides a direct test of the assumption while the Farrell model does not. Given the critical nature of this assumption, the availability of a direct test proves to be a substantial advantage.

Five additional hypotheses may be tested. The first is that the groups of departments act as if they were profit maximizers. Yotopoulos and Lau demonstrate that a necessary and sufficient condition for profit maximization is that the coefficient for each variable input in the UOP profit equation equals the coefficients in the relevant derived input demand equation for each departmental group. The null hypotheses and calculated F-values for this test are shown in table 5.

It would appear we may accept the general hypothesis that, given their input prices, meat departments in this sample follow the general rule of profit maximization with respect to the variable inputs, meat and labor. However, it is with respect to this test that the UOP profit model is flawed. The variables for wholesale meat price (c_1), normalized wage (c_2), and capital service flow (K) appear on the right-hand side of equation (1) but not of equations (2) or (3). A difficuty arises because the hypotheses cannot be tested directly from equations (1), (2), and (3), since estimates of the covariances between coefficients are unavailable from the separate equations. When these equations are pooled to obtain the residual sum of squares from an equation incorporating the appropriate restriction under the null hypothesis, a series of zeros must be entered in the half of the data set representing equation (2) or (3) for each of these three variables. As a result, the multicollinearity between the three must be high. In this data set, the three correlation coefficients were: pooled $r_{c_1, c_2} = -0.996$, pooled $r_{c_1, K} = -0.997$, and pooled $r_{c_2, K} = 0.996$.

The large correlation coefficients create a potential testing problem since the associated standard errors and covariance coefficients will be inflated to an unknown degree. This will bias the test toward acceptance of the null (profit-maximization) hypothesis. Since no alternative test is available, we accept profit-maximizing behavior for this sample while recognizing that a bias may exist.

The remaining hypotheses deal with efficiency. The first efficiency hypothesis is that economic efficiency does not differ across groups of departments. Since the input coefficients are constant across groups, this hypothesis implies that the intercept values for each group of departments in equation (1) are equal. This is equivalent to the test that $\beta_1 = \beta_2 = \beta_3 = 0$. The F-value calculated for this test is 8.68 while the critical value is F (3,25) = 2.99 at the 5% significance level. The null hypothesis of equal economic efficiency is rejected.

The second efficiency test is to determine the source of this difference in economic efficiencies. The intercept values and test statistics appear in table 6. The null hy-

Table 5. A Test of Profit-Maximizing Behavior with Respect to the Variable Inputs

Meat Department Grouping	Null Hypothesis	Computed F-Value[a]
Medium-volume carcass		
Meat	$\alpha_1 = \alpha_3$	0.1421
Labor	$\alpha_2 = \alpha_4$	0.0006
Large-volume carcass		
Meat	$\alpha_1 = \alpha_3 + \beta'_1$	0.0057
Labor	$\alpha_2 = \alpha_4 + \beta''_1$	0.2045
Medium-volume fabricated		
Meat	$\alpha_1 = \alpha_3 + \beta'_2$	0.0013
Labor	$\alpha_2 = \alpha_4 + \beta''_2$	0.2166
Large-volume fabricated		
Meat	$\alpha_1 = \alpha_3 + \beta'_1 + \beta'_2 + \beta'_3$	0.0001
Labor	$\alpha_2 = \alpha_4 + \beta''_1 + \beta''_2 + \beta''_3$	0.2677

[a] The critical F-value for all tests is F (1,53) = 4:02 at the 5% level of significance.

Table 6. A Test of Equal Economic Efficiency between Pairs of Meat Department Groupings

System (ranked from least to most efficient)	Intercept Value	Intercept Hypothesis	Computed t-Value[a]
Medium carcass (MC)	4.7417	MC = LC	4.849[b]
Medium fabricated (MF)	5.2626	MF = LF	1.100
Large fabricated (LF)	5.6101	MC = MC	1.175
Large carcass (LC)	6.0392	LC = LF	1.054
		MC = LF	1.858[c]
		MF = LC	1.657

[a] The critical value for all tests is $t(25) = 2.06$ at the 5% significance level.
[b] Significant at the 5% level.
[c] Significant at the 10% level.

Table 7. A Test of Equal Meat Pricing Efficiency between Meat Department Groupings

System (ranked from least to most efficient)	Intercept Value	Intercept Hypothesis	Computed t-Value[a]
Medium carcass (MC)	−19.787	MC = LC	4.335
Large carcass (LC)	− 7.449	MC = MF	5.333[b]
Medium fabricated (MF)	− 5.793	MC = LF	5.873[b]
Large fabricated (LF)	− 4.732	LC = MF	0.501
UOP meat coefficient	− 4.343	LC = LF	0.539
		MF = LF	0.192

[a] The critical value for all tests is $t(25) = 2.06$ at the 5% level of significance.
[b] Significant at the 5% level.

pothesis of equal economic efficiencies is rejected for two pairs: medium carcass stores are significantly less economically efficient than either large carcass or large fabricated stores. In other words, large-volume meat departments as a group are equally efficient regardless of meat handling systems. Medium-volume meat departments using the fabricated handling system equal the economic efficiency of their larger counterparts while medium-volume departments using the traditional carcass system do not.

This difference in economic efficiency could come from a difference in pricing efficiency (variable resources continued in their most efficient proportions) or a difference in technical efficiency (obtaining the maximum output given a set of variable and fixed inputs).

The third efficiency test examines relative pricing efficiency between the four groupings for each variable input. This test is derived from the input demand equations and the relevant hypotheses are: for meat, $\beta'_1 = \beta'_2 = \beta'_3 = 0$; and for labor, $\beta''_1 = \beta''_2 = \beta''_3 = 0$. The relevant F-tests are: for meat, $F = 12.695$; and for labor, $F = 12.539$, while the critical value is $F\,(3,28) = 2.95$ at the 5% significance level. For both meat and labor, the hypothesis of equal price efficiency is rejected.

The fourth efficiency test is to determine the source of these differences in price efficiencies. Yotopoulos and Lau (1973) demonstrate that maximum price efficiency within the sample occurs when the intercept value of the derived input demand equation equals the coefficient for that variable input in the UOP profit function. The intercept values ranked from least efficient to most efficient and the test statistic for equal efficiencies between departmental groupings appear in table 7 for meat and in table 8 for labor. The departmental groupings are ranked from least to most efficient based on the criterion that absolute price efficiency occurs when the intercept value of the derived demand equation equals the coefficient for that variable input in the UOP profit function. Absolute tests of the difference between the individual intercept values and the UOP input coefficient are not performed because of the multicollinearity problem cited earlier. Since the relative tests may be performed without pooling the equations, this problem is avoided.

In an earlier test we found medium-volume carcass departments significantly less economically efficient than large-volume departments as a group. For pricing efficiency, we find medium carcass departments less efficient with respect to meat but more efficient with respect to labor. This would

Table 8. A Test of Equal Labor-Pricing Efficiency between Meat Department Groupings

System (ranked from least to most efficient)	Intercept Value	Intercept Hypothesis	Computed t-Value[a]
Medium fabricated (LF)	−0.613	MC = LC	4.587[b]
Medium fabricated (MF)	−0.955	MC = MF	5.127[b]
Large carcass (LC)	−1.041	MC = LF	5.483[b]
Medium carcass (MC)	−3.856	LC = MF	0.121
UOP labor coefficient	−4.011	LC = LF	0.374
		MF = LF	0.287

[a] The critical value for all tests is $t(25) = 2.06$ at the 5% level of significance.
[b] Significant at the 5% level.

seem to be contradictory at first but is resolvable.

Labor is a lumpy input. Meat departments with weekly sales below \$4,000 generally employ one meat cutter, departments with sales between \$4,000 and \$8,000 generally employ two meat cutters, and departments with sales in excess of \$8,000 generally employ three or more. Medium-volume departments switching from a carcass- to a fabricated-handling system generally find that they cannot reduce their number of meat cutters below two in the short run. As a result, they are penalized in labor-pricing efficiency for a relative excess of labor and appear to be not significantly different from medium-volume carcass departments in total economic efficiency. However, for the variable input under short-run discretionary control, meat, there is a gain in pricing efficiency. It is the inability to reduce the labor input which offsets this gain and causes the overall economic efficiencies of medium-volume carcass and fabricated departments to appear equal. There is, of course, the possibility that meat cutters under a fabricated system may be diverted to other productive activity not measured in this study. The assumption for this research effort was that the retail meat output appeared identical to consumers under either system. With a fabricated system, meat cutters may devote more time to maintaining the display case, merchandising the meat, and providing customer service.

We may now estimate actual efficiency levels. The estimates may be calculated from equations (1), (2), and (3), as described by Yotopoulos and Lau. The parameters for meat-pricing efficiency, labor-pricing efficiency, and technical efficiency are given in table 9. No direct test of relative significance is available for technical efficiency. Maximum pricing efficiency is obtained when the parameters are equal to one. Technical efficiency continues to increase with larger values of its parameter.

Since the medium-volume carcass system meat departments are the least economically efficient group, let us compare performance with the medium-volume, fabricated-system departments. In this sample, the medium fabricated departments show a gain in relative meat pricing efficiency of 7.5% over the medium carcass departments: $\frac{0.621}{0.578} = 1.075$. The medium fabricated departments also show a gain in technical efficiency of 7.0% over the medium carcass departments: $\frac{6.135}{5.737} = 1.070$.

Table 9. Efficiency Parameters

Meat Department Grouping	Efficiency Parameter
Medium carcass	
Meat	0.578
Labor	2.741
Technical	5.737
Medium fabricated	
Meat	0.621
Labor	3.908
Technical	6.135
Large carcass	
Meat	0.592
Labor	3.477
Technical	7.002
Large fabricated	
Meat	0.623
Labor	4.436
Technical	6.927

However, medium fabricated departments are less labor-pricing efficient, $(2.741)(3.908)^{-1} = 70\%$, than medium carcass departments. Since the two systems are not significantly different in overall efficiency for medium-volume departments, relative labor inefficiency may overwhelm gains in meat pricing and technical efficiency, at least in the short run.

Summary and Conclusions

The UOP profit model and the Farrell linear programming model were used to investigate the relative technical, pricing, and economic efficiencies of four groups of retail meat departments: medium- and large-volume departments utilizing carcass-meat-handling systems, and medium- and large-volume departments utilizing fabricated-meat-handling systems. The Farrell model proved less satisfactory in evaluating this sample. When scale (volume) of operation was included, the underlying assumption of a neutral shift in the production function was violated. Of greater concern, however, is the fact that no direct test of this assumption is available from the Farrell model and the problem could go undetected except in cases of obvious violation. The Farrell model provides none of the standard statistical measures of goodness-of-fit provided by the UOP regression model and

proceeds in the absence of the output-price data incorporated in the UOP approach. In addition, the Farrell model suffers from biased technical efficiency cones which are not present in the UOP model.

In short, the UOP profit model appears to be a superior tool. This model, however, is biased toward acceptance of the null hypothesis concerning profit-maximizing behavior. Given the nature of the test used for this hypothesis, acceptance of a rational, economic decision-making process becomes more a matter of a priori reasoning and less a matter of statistical verification.

One more caution deserves to be raised. Although the UOP regression model allows the standard statistical tests, they must be interpreted with some caution. Significance levels, as commonly understood in statistics, apply to single tests. When a model requires a series of tests utilizing the same data set, the level of protection is a good deal less than is indicated by the individual significance levels. Analysts using this model should, therefore, not rely on the statistical tests to the exclusion of their previous knowledge concerning the system under investigation.

The profit model for this sample indicates that medium-volume carcass departments comprised the only group with significantly different efficiency parameters than the other three groups. This group was significantly less pricing efficient with respect to the meat input and ranked the least technically efficient although no significance test for this characteristic was available.

Although a fabricated system appears to produce a gain in technical and meat-pricing efficiency for medium-volume departments, the labor requirement is not reduced proportionally, at least in the short run. This is due in part to existing union agreements and in part to the inherent lumpiness of the input itself. The inability to scale down labor causes the conversion to fabricated-handling systems to be less desirable than would be the case under continuously variable labor inputs. It remains to be seen what long-run pattern of labor utilization in the store will develop. In the short run, any increase in labor efficiency would occur primarily at the central fabrication plant, not at the retail store.

The unit of study for this research effort was the meat department in individual retail supermarkets. Additional benefits from converting to a vertically integrated fabrication system may be realized. These benefits would be important to the industry but were beyond the scope of this study. In fact, based on the results of this analysis, there is substantial incentive for the stores to integrate backward into their own fabrication to help solve the short-run labor utilization problem. Under such a system, meat cutters could be moved from the store to the central fabrication unit without having to terminate present employees.

At the individual store level, it appears likely that both the traditional carcass system and the newer fabricated-handling system will continue to exist side by side in the industry for some time. No clear advantage for the fabricated system existed for the large-volume departments in this sample. Some fabricated departments in this group were more efficient than large-volume carcass departments; some were less efficient. Meat departments of independent retail stores with weekly sales in excess of $10,000 considering the change would do well to adopt the fabricated system on a trial basis before committing themselves.

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Effects of Changes in the Level of U.S. Beef Imports

J. W. Freebairn and Gordon C. Rausser

Regulatory policies pertaining to beef imports are analyzed on the basis of an econometric model of the livestock sector. The model encompasses the consumption, production, trade, and retail and farm prices of fed beef, other beef, pork, poultry, and inventory levels of livestock used in the production of these products. In terms of consumer welfare, increased beef imports reduce the retail price of all meats with the larger reductions occurring for lower quality of manufacturing beef products, while in the case of producer welfare such increases reduce slaughter steer, cull cow, and feeder calf prices with a heavier burden being placed on cattle breeders relative to cattle feeders.

Key words: import, forecasts, beef, pork, poultry, inventory, consumer, producer.

Over the past fifteen years, a number of policies affecting U.S. imports of beef have resulted in considerable controversy. Beef producers have contended that unrestricted beef imports unduly reduce their incomes and could cause irreparable harm to the domestic livestock industry. This led to the 1964 Meat Import Bill (P.L. 88-482) which allowed for quota limitations on beef imports, and following the fall in cattle prices in 1974, producers renewed their calls for effective import controls. Consumers have argued that increases in beef prices in the late 1960s and early 1970s were caused at least in part by beef import quotas. These pressures contributed to the decisions to relax the quota levels in 1968 and to abandon the quotas in 1972. Current annual beef import levels of around 2 billion pounds (carcass weight) amount to about 7.5% of total U.S. beef consumption and about 27.5% of U.S. consumption of lower quality nonfed beef. In this context, this paper reports some results of an econometric study designed to assess the time path of effects of alternative levels of beef imports on retail meat prices, farm livestock prices, and growth of the beef industry in terms of production levels and cattle inventory numbers.[1]

The econometric model describes the consumption, production, trade, and retail and farm prices of fed beef, other beef, pork and poultry, and inventory levels of livestock used in the production of these products. Fed beef is classified as meat produced from feedlot cattle while other beef comprises cull cows, range-fed beef, and imported beef.[2] While approximate and crude, the beef segregation serves three important purposes in the analysis: fed beef represents higher quality beef and has a higher income elasticity of demand (see, for example, the studies listed in note 1); for the main part, different sets of producers are involved (see, for example, McCoy); and imported beef is of comparable quality to domestically produced other beef (see, for example, USDA, *Livestock and Meat Situation,* May 1968). Because of interdependencies at both the consumption and produc-

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[1] A number of studies reported in the literature have made estimates of the effects of beef imports. A USDA study (*Livestock and Meat Situation,* Aug. 1963), Langemeir and Thompson, Jackson, and Houck estimate short-run models of the beef sector to assess the effects of beef imports on meat and cattle prices. More specifically, Jackson considers effects on resource returns, and Houck considers effects on the consumer price index. These studies are not suitable for analyzing the longer-run effects of imports on production and inventory levels. Crom's quarterly model of the beef and pork sectors may be used to evaluate the effects of beef imports. However, his model ignores poultry, and to our mind, Crom's assumption that producer decisions are made independently of current period prices—an assumption made to attain a recursive model—involves a serious misspecification. This perception is based upon Hayenga and Hacklander's work which reveals important current price dependencies in a model estimated from monthly data.

[2] This is the segregation scheme employed by Crom and by Houck. Other segregation schemes include classification into steer and heifer beef for our category and cow and imported beef for the other category, e.g., USDA, *Livestock and Meat Situation* (Aug. 1963) and Langemeir and Thompson or a detailed breakdown of carcasses by quality type, e.g., Coleman. For an evaluation of the alternative segregation schemes, see Freebairn and Rausser.

tion levels, the model embraces decision-making behavior in the pork and poultry sectors as well as in the beef sector.

A set of reduced form equations is derived from a simultaneous equation model. Estimated multipliers are used to analyze the time path of effects of changes in beef imports on performance of the livestock sector.[3] Finally, the estimated multipliers are employed to evaluate the effects of a 200-million-pound and a 700-million-pound change in annual beef imports.

Economic Model

A simultaneous equation model is specified to describe the more important causal relationships underlying the behavior of decision units in the fed beef, other beef, hog, and poultry sectors; decisions affecting the dairy sector, the grain and livestock feed sector, and other sectors are regarded as predetermined. Consumer demand equations describe behavior at the retail level. A set of margin equations link retail and farm prices. Behavior of domestic producers is described in terms of meat production equations and equations for the inventories of animals for future period production. Equations for net trade and stock changes provide the link between consumption and domestic production levels.

The consumer demand equations are based upon the neoclassical theory of utility maximization. We assume approximate plausibility of the multiple-stage, consumer maximization model whereby fed beef, other beef, pork, and poultry belong to a separable commodity group, meat. (For an empirical justification of this specification, see George and King.) Then, quantity demanded for each meat is a function of the prices for each of the four meats, a price index for other products, and disposable income.

The retail-farm price margin equations allow for both the percentage and the absolute margin. Provision is made for wage rates as a measure of the costs of providing retailing and wholesaling services and for the practice of price leveling whereby marketers stabilize the variability of retail prices relative to farm prices. Price of the intermediate product feeder calves is expressed as a function of factors representing the demand for feeder calves (measured as expected profitability of cattle feeding) and the supply of feeder calves.

Models describing producer decision making are used to derive equations describing the annual production of fed beef, other beef, pork, and poultry and the inventories of cattle placed in feedlots, of breeding cows, and of farrowing sows. While the poultry industry is treated as an independent sector, allowance is made for interdependence between decisions affecting the hog and cattle sectors, e.g., many Midwest farmers actively decide on the allocation of grains and other resources between hogs and cattle feeding and in some cases cattle breeding. Investment decision models under conditions of imperfect market knowledge are specified, i.e., decisions are made so as to maximize the expected time sequence of net returns, subject to a set of physical production constraints including livestock demographic constraints, initial conditions, and expectations about market prices.[4] The derived decision equations for meat production and for closing livestock inventories are functions of the beginning inventory levels, expected market prices for the activity and for competing activities, the expected variability of market prices, prices of important purchased imputs, and technological shift factors.

To keep the model manageable, net foreign trade of meat products and annual meat stock changes are treated as predetermined variables. Aggregate beef exports and changes in beef stocks and, in most years, changes in the net trade along with the stocks of pork and poultry have been fairly constant and relatively unimportant (compared to production and consumption) over the same period. In contrast, beef imports have varied widely and have been relatively important. However, from 1965 to 1972 beef imports were regulated to a large extent by voluntary quota arrangements between the United States and the major beef-exporting countries under the shadow of the 1964 Meat Import Bill.

Estimated Structural Model

Observations for the period 1956 through 1971 are used to estimate the parameters of the

[3] Also, the model may be employed to trace out the time path of effects of changes in other exogenous variables including income, corn price, and technology changes.

[4] A formal development of the model is given in Rausser (1973). Specific models underlying the equations specified in this paper are reported in Freebairn and Rausser. An earlier empirical application may be found in Rausser (1971).

stochastic equations. Equations with two or more current endogenous variables are estimated by three-stage least squares (3SLS), and other equations are estimated by ordinary least squares (OLS).[5] In applying 3SLS, the problem of undersized sample is encountered, i.e., the number of predetermined variables exceeds the number of sample observations. Following Swamy and Holmes and Fischer and Wadycki, the 3SLS estimator becomes a two-stage Aitken (TSA) estimator. The estimates have the large sample properties of consistency and asymptotic efficiency.

The estimated relations reported are the preferred estimates. Some experimentation was involved in the selection of expected price and anticipated price variability variables, in choice of the mathematical form, and the selection of included variables. Criteria for selection involved a subjective weighting of consistency of signs and magnitudes of the estimated parameters, compared to a priori reasoning and previous studies, statistical significance of the estimates, and explanatory power of the estimated equations. The expected farm price variables are specified as a distributed lag of prices in the current and past year with an arithmetic lag structure;[6] the same specification was used for all equations on the assumption that producer price expectations are formed in a similar fashion for all commodities. A three-year moving average standard deviation of current and historical prices is used as a measure of anticipated price variability. (For a more extensive discussion of the use and measurement of anticipated price variability variables, see Just or Rausser [1971, 1973].)

Estimates of the consumer demand equations are reported in table 1. Per capita consumption of each product is regressed against deflated retail prices and deflated per capita disposable income. In the fed beef and other beef equations, the prices of pork and poultry have been combined, and in the pork and chicken equations, the prices of fed beef and other beef have been combined to save degrees of freedom and in the case of the beef prices to reduce the effects of multicollinearity; the partial correlation between the fed beef and other beef prices was 0.85.[7] Negative price elasticities are indicated for the four meats (estimated mean price elasticities of −0.83, −0.43, −0.84, and −0.85 for fed beef, other beef, pork, and chicken, respectively). Interestingly, the direct price elasticity of demand is greater for fed beef than for other beef; a similar finding was observed by Houck. The estimated income elasticities (1.61, −0.21, 0.46, and 0.75 for fed beef, other beef, pork, and chicken, respectively) indicate that fed beef is a superior good while other beef is an inferior good; this pattern was found by Langemeir and Thompson and is supported by cross-section data from the USDA 1965 Household Food Consumption Survey. The apparent complementary relationships indicated by the negative cross-price parameter estimates may be of a spurious nature, or as argued by Hayenga and Hacklander who encountered similar results, they might be explained by preferences for variety in the meat menu. In general, the estimated parameters are similar to those reported for other studies of meat demand.

Estimates of equations describing the price

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[5] The complete representation of the U.S. livestock sector is specified as a block recursive model. Four blocks are included in the specification. The first two blocks contain one equation each, and thus each of these blocks has only one endogenous variable (see tables 1–6 for a listing of the equations). The single equation blocks are the domestic calf supply equation (4.1) and the poultry production equation (5.3). The third block contains twenty-six relations describing the current prices and quantities of meat products consumed and produced (with the exception of poultry). This meat consumption and production block consists of the consumer demand relations (1.1)–(1.4); the price spread relations (2.1)–(2.4); the producer price equations (2.5) and (6.1)–(6.4); the beef supply and production equations (3.1), (3.2), (6.5), and (6.6); the hog supply and production equations (5.1) and (6.7); the calf import equation (4.3); the feeder calf inventory equation (6.9); the poultry domestic supply equation (6.7); the two inventory stock relations for beef cows (3.3) and sows (5.2); for cattle placed on feed equation (3.4); and for steers and heifers on the range equation (6.10). The last block contains a single equation, viz., the relation for calves slaughtered equation (4.2). In general terms, the recursive nature of structural equations is such that given beginning stocks in period t, short-run forces determine prices and quantities supplied in that year, and these prices in turn influence the beginning stocks for the following $(t+1)$ period. Even though the matrix of parameters for the endogenous variables entering the inventory equations on one hand and those for endogenous variables entering the demand, margin, and production equations on the other is block triangular, the relationship between two sets of equations is not block recursive. This is simply because the second requirement for a block recursive specification between any two sets of equations, viz., the covariance matrix of the associated disturbance terms be block diagonal with conforming blocks, is not met. More specifically, our empirical results clearly indicate that the disturbance terms entering the production and inventory equations are strongly related. These results were expected since the production and inventory equations were derived from a common decision model, and thus their error terms include the effects of common omitted variables.

[6] Other specifications tested were the geometric lag, extrapolative expectations model, quadratic lag, extrapolative expectations model, quadratic polynomial model, and variations of the number of lags. In all cases, the specifications assumed stationary price expectations implying no trends or cyclical variations.

[7] Estimated equations with all the prices as separate variables indicated that the estimated parameters on the variables which are combined in table 1 were not significantly different (at the 0.05 level) from each other.

Table 1: Estimates of Consumer Demand Equations

Demand Equation	Normalized Variable	Explanatory Variables								$\hat{\sigma}$	R^2	D.W.
		Constant	Dp_{fb}^r	Dp_{ob}^r	Dp_b^r	Dp_p^r	Dp_c^r	Dp_{om}^r	DPy			
Fed beef (1.1)	Pq_{fb}^c	−11.462	−0.5470	0.6453				−0.2441	39.130	2.135	0.98	1.71[b]
		(19.247)[a]	(0.3101)	(0.2485)				(0.1168)	(2.210)			
Other beef (1.2)	Pq_{ob}^c	77.969	−0.3428	−0.2728				0.1895	−3.136	0.894	0.93	2.14[b]
		(8.150)	(0.1326)	(0.1090)				(0.0523)	(0.949)			
Pork (1.3)	Pq_p^c	38.715			0.3472	−0.8141	0.5270		11.904	1.233	0.93	2.07[b]
		(10.222)			(0.0608)	(0.0511)	(0.0792)		(1.710)			
Chicken (1.4)	Pq_c^c	24.240			0.1983	0.0883	−0.7019		8.984	0.816	0.98	1.59[b]
		(6.638)			(0.0403)	(0.0336)	(0.0490)		(1.085)			

Sources and notes: Endogenous variables: Pq_{fb}^c—per capita fed beef consumption, lb. carcass weight (Crom); Pq_{ob}^c—per capita other beef consumption, lb. carcass weight (Crom); Pq_p^c—per capita pork consumption, lb. carcass weight (USDA, *Livestock and Meat Statistics*); Pq_c^c—per capita chicken consumption, lb. carcass weight (USDA, *Poultry and Egg Situation*); Dp_{fb}^r—deflated retail price of choice grade beef, ¢/lb. (USDA, *Livestock and Meat Statistics*); Dp_{ob}^r—deflated retail price of hamburger, ¢/lb. (USDA, *Livestock and Meat Statistics*); Dp_b^r—weighted average deflated fed beef and other beef prices; Dp_p^r—deflated retail price of pork, ¢/lb. (USDA, *Livestock and Meat Statistics*); Dp_c^r—deflated retail price of fryers, ¢/lb. (USDA, *Poultry and Egg Situation*); Dp_{om}^r—weighted average deflated pork and chicken prices; $D = 1/CPI$—the deflator operator and CPI is the consumer price index (U.S. Dep. of Commerce); $P = 1/Pop$—the per capita operator and Pop is U.S. resident population, m. (U.S. Dep. of Commerce). Exogenous variables: DPy—deflated per capita disposable income, $1000 (U.S. Dep. of Commerce).

[a] Estimated standard error.

[b] Durbin-Watson statistic in the inconclusive zone at 0.05 level.

margin between retail meat prices and farm prices for the comparable animals are reported in table 2. As hypothesized, the margin is positively related to the farm price of the animal and to the wage rate and is negatively related to changes in farm prices. The feeder calf price is positively related to the expected price of fed cattle and negatively to changes in the supply of feeder calves.

Annual production of fed beef is explained by the number of cattle placed in feedlots in the previous year (table 3). Alternative specifications, including cattle and grain prices as explanatory variables, did not result in significantly better estimates.[8]

Equations describing the interrelated decisions for the inventory of beef cows and the production of other beef are reported in table 3. In equation (3.3), the parameters on the inventory levels of beef cows and dairy cows were prespecified as 125 and 70, respectively, to reflect culling rates of 25% and 14% and an average slaughter weight of 500 pounds;[9] the procedure preserves degrees of freedom and eliminates an important element of multicollinearity associated with the partial correlation coefficient of −0.98 between the two inventory variables. Increases in the expected profitability of raising calves and decreases in the slaughter value of cull cows simultaneously reduces the production of other beef and increases the inventory of beef cows. Estimated elasticities of the closing inventory of beef cows with respect to the expected price of feeder calves and the price of cull cows at 0.2 and −0.1 are highly inelastic.

Attempts to estimate the relation explaining decisions to place cattle in feedlots, equation (4.1), have not been entirely successful. Inclusion of the price of feeder calves as an explanatory variable, either in its absolute form or in the feed margin form, failed to support the hypothesis that cost of the feeder calf input influences decisions in a significant way. In part, this may be attributed to the level of collinearity between fed beef and feeder calf prices—partial correlation coefficients between feeder calf price and fed beef price or expected fed beef price were 0.90 and 0.93, respectively. In addition, the magnitude of the parameter on the supply of feeder calves (1.04) is excessive when one recalls that feeder calves include replacement heifers. Perhaps the feeder calf supply variable is acting also as a proxy for omitted variables associated with structural change, e.g., the willingness and the knowledge of how to feed cattle. Inclusion of variables for expected hog profitability failed to isolate significant interdependencies between decisions to feed cattle or hogs. It is estimated that the expected price of fed beef and the price of corn have a small influence on the number of cattle placed on feed with elasticities of 0.2 and −0.1, respectively.

Table 4 reports the estimated equations for decisions affecting the supply of calves. The number of calves raised, equation (4.1), is explained as a ratio of the inventory of beef cows and dairy cows; data were not available to allow for estimation of different survival rates between beef and dairy herds. In the equation for calf slaughter, equation (4.2), most calves slaughtered are assumed to be dairy calves (for supporting evidence, see USDA, *Livestock and Meat Situation* [May 1969, May 1970]) with the inventory of dairy cows entering as a proxy variable. In this equation, the feeder calf price represents the opportunity cost of calf slaughter. No significant relationship between calf slaughter and milk prices or the rate of change of the dairy herd was found.

Imports of feeder calves, equation (4.3), are influenced by the price of feeder calves. The deliberate and simplying omission of variables for the supply and demand of feeder calves in Canada and Mexico lies behind the poor explanatory power of this equation. With respect to the price of feeder calves, elasticity estimates for calves slaughtered and calves imported of −0.4 and 1.5, respectively, were obtained.

Equations for the production of pork and the inventory of farrowing sows are reported in table 5. Increases in the expected return from hogs as influenced by a higher expected output price or by a lower cost of grain inputs induce producers to lower the pig slaughter rate while augmenting the inventory of sows for future production. Estimates of the elasticity of the inventory of sows with respect to the expected hog price and the corn price of 0.75 and −0.4, respectively, are comparable to those reported by Dean and Heady and

[8] In other studies (e.g., Langemeir and Thompson, Crom), these variables also had little influence, and their associated parameter estimates were not significantly different from 0.

[9] This prior parameter information was derived from USDA, *Livestock and Meat Situation* (May 1970) and Crom. When an unconstrained estimator was employed, the resulting parameter estimates for k_{3-1} and k_{4-1} were not significantly different from 70 and 125, respectively.

Table 2. Estimates of Equations for Price Margins and for Farm Price of Feeder Calves

Equation	Normalized Variable	Explanatory Variables: Constant	p_{fb}^f	p_{ob}^f	p_p^f	p_c^f	Δp_{fb}^f	Δp_{ob}^f	Δp_p^f	Δp_c^f	w	$0.67p_{fb}^f + 0.33p_{fb-1}^f$	Δk_{fo}	$\hat{\sigma}$	R^2	D.W.
Fed beef margin (2.1)	s_{fb}	5.0065 (2.7352)	1.803 (0.1713)[a]				−0.4219 (0.1156)				8.0511 (0.9230)			1.231	0.98	1.79[c]
Other beef margin (2.2)	s_{ob}	6.3178 (2.2741)		1.0988 (0.2336)				−0.9260 (0.2003)			4.8637 (1.3536)			1.795	0.92	1.22[b]
Pork margin (2.3)	s_p	9.5175 (1.4189)			1.1784 (0.1068)				−0.4824 (0.0802)		5.0228 (0.5760)			0.947	0.98	2.27[c]
Chicken margin (2.4)	s_c	3.2969 (2.1541)				0.9899 (0.0882)				−0.2390 (0.0925)	2.7083 (0.3519)			0.592	0.87	1.51[b]
Feeder calf price (2.5)	p_{fd}^f	−19.414 (3.678)										1.9244 (0.1481)	−1.3633 (0.4254)	1.621	0.90	1.75[c]

Sources and notes: Endogenous variables: p_{fb}^f—farm price of choice slaughter steers, Omaha, \$/100 lb. (USDA, *Livestock and Meat Statistics*); p_{ob}^f—farm price of utility cows, Omaha, \$/100 lb. (USDA, *Livestock and Meat Statistics*); p_p^f—farm price of barrows, gilts, and sows in seven markets, \$/100 lb. (USDA, *Livestock and Meat Statistics*); p_c^f—average price received by broiler producers, ¢/lb. (USDA, *Poultry and Egg Situation*); p_{fd}^f—farm price of good and choice feeder steers, Kansas City, \$/100 lb. (USDA, *Livestock and Meat Statistics*); k_{fo}—supply of feeder calves, millions, computed from equation (6.9); s_i—retail-farm price margins, computed from equations (6.1)–(6.4). Exogenous variables: w—wage rate in meat-packing industry, \$/hr. (U.S. Dep. of Commerce).

[a, b] See table 1.

[c] No significant autocorrelation at 0.05 level.

Table 3. Estimated Equations for Production of Fed Beef and of Other Beef, for the Inventory of Beef Cows, and for Number of Cattle Placed in Feedlots

Equation	Normalized Variable	Explanatory Variables: Constant	p_{ob}^f	$0.67p_{fb}^f + 0.33p_{fb-1}^f$	$0.67p_{fo}^f + 0.33p_{fc-1}^f$	Vp_{fo}^f	p_k^f	k_{fb-1}	k_{r-1}	k_{fo}	$\hat{\sigma}$	R^2	D.W.
Production of fed beef (3.1)	q_{fb}^p	73.139 (307.690)[a]						635.3 (16.3)			397.3	0.99	1.42[c]
Production of other beef (3.2)	$q_{ob}^p - 125\,k_{d-1} - 70\,k_{b-1}$	3610.6 (1062.4)	139.56 (53.11)		−184.9 (49.0)	86.25 (50.69)			55.51 (69.30)		331.1	0.79	1.63[b]
Inventory of beef cows (3.3)	Δk_b	−0.01528 (0.9372)	−0.2147 (0.1050)		0.2027 (0.0683)	−0.3405 (0.1015)					0.651	0.74	1.71[b]
Cattle placed on feed (3.4)	k_{fb}	−12.821 (2.457)		0.1803) (0.0803)			−2.0076 (1.7105)			1.0399 (0.0417)	0.686	0.99	1.57[b]

Sources and notes: Endogenous variables: q_{fb}^p—fed beef production, m. lb. carcass weight (Crom); p_{ob}^p—other beef production, m. lb. carcass weight (Crom); p_{ob}^f—farm price of utility cows, Omaha, \$/100 lb. (USDA, *Livestock and Meat Statistics*); p_{fc}^f—farm price of good and choice feeder steers, Kansas City, \$/100 lb. (USDA, *Livestock and Meat Statistics*); Vp_{fc}^f—three-year moving standard deviation of p_{fc}^f; k_b—inventory of beef cows, m. (USDA, *Livestock and Meat Statistics*); k_{fb}—cattle placed on feedlots, m. (Crom); k_r—feeder calves not placed on feedlots, computed in equation (6.10); k_{fc}—supply of feeder calves, m. computed in equation (6.9). Exogenous variables: p_k^f—farm price of corn, \$/bu. (USDA, *Agricultural Statistics*); k_d—inventory of dairy cows, m. (USDA, *Livestock and Meat Statistics*).

[a, b] See table 1.

[c] See table 2.

Table 4. Estimated Equations for Calves Raised, Slaughtered, and Imported

Equation	Estimator	Normalized Variable	Constant	p_{fc}^f	$k_{b-1} + k_{d-1}$	k_{d-1}	$\hat{\sigma}$	R^2	D.W.
			Explanatory Variables						
Calves raised (4.1)	OLS[c]	k_c			0.8819 (0.0060)		1.131	0.96	—
Calves slaughtered (4.2)	OLS[d]	c	0.9614 (0.7276)[a]	−0.1483 (0.0368)		0.4408 (0.1691)	0.4182	0.71	1.79[b]
Calves imported (4.3)	TSA	m_c	−0.3881 (0.4039)	0.0407 (0.0146)			0.4130	0.30	1.91[b]

Sources and notes: Endogenous variables: p_{fc}^f—farm price of good and choice feeder steers, Kansas City, $/100 lb. (USDA, *Livestock and Meat Statistics*); k_c—domestic calves born less deaths, m. (USDA, *Livestock and Meat Statistics*); c—calves slaughtered, m. (USDA, *Livestock and Meat Statistics*); m_c—imports of feeder calves, 200–700 lb. liveweight, m. (USDA, *Livestock and Meat Statistics*); k_b—inventory of beef cows, m. (USDA, *Livestock and Meat Statistics*). Exogenous variables: k_d—inventory of dairy cows, m. (USDA, *Livestock and Meat Statistics*).

[a, b] See table 1.

[c] Constant term constrained to zero and for this reason the Durbin-Watson statistic is not reported.

[d] Corrected for first-order autocorrelation with estimated parameter 0.71.

others. Prospects for the cattle industry measured in terms of the expected price of fed beef indicate some competition for resources between the hog and cattle sectors. Note also that the technical shift variable, pigs saved for litter, has a significant influence on decision making in the hog sector.

Chicken production, equation (5.3), is explained by the lagged prices of chicken and corn and by a productivity shift variable with the latter being the most important explanatory variable. The absence of significant current price variables in the equation concurs with Lee and Seaver's observation of about a year's lag between planning and slaughter in the poultry industry.

Identities which complete the structural model are reported in table 6. Equations (6.1)–(6.4) link the retail and farm prices by the marketing margins. Equations (6.5)–(6.8) relate the aggregate consumption of each meat to domestic production, trade, and to stock

Table 5. Estimated Equations for the Production of Pork and Chicken, and for the Inventory of Farrowing Sows

Equation	Normalized Variable	Constant	$0.67P_{fb}^f + 0.33P_{fb-1}^f$	$0.67P_p^f + 0.33P_{p-1}^f$	P_{c-1}^f	P_h^f	P_{h-1}^f	k_{h-1}	n_p	n_c	$\hat{\sigma}$	R^2	D.W.
			Explanatory Variables										
Production of pork (5.1)	q_p^p	−47384 (6991)[a]	241.1 (53.4)	−234.3 (76.4)		2844 (1011)		613.8 (161.6)	6469 (906)		457.3	0.90	2.47[b]
Inventory of sows (5.2)	Δk_h	29.481 (3.634)	−0.1627 (0.0218)	0.5260 (0.0339)		−4.9606 (0.5540)			−4.0732 (0.5322)		0.233	0.95	2.10[b]
Production of chicken (5.3)	q_c^p	2337 (879)			82.7319 (49.5185)		−1289 (752)			53.99 (3.48)	200.5	0.98	2.12[c]

Sources and notes: Endogenous variables: q_p^p—pork production, m. lb. carcass weight (USDA, *Livestock and Meat Statistics*); q_c^p—chicken production, m. lb. carcass weight (USDA, *Poultry and Egg Situation*); k_h—number of sows farrowing, m. (USDA, *Livestock and Meat Statistics*); p_{fb}^f—farm price of choice slaughter steers, Omaha, $/100 lb. (USDA, *Livestock and Meat Statistics*); p_p^f—farm price of barrows, gilts, and sows in seven markets, $/100 lb. (USDA, *Livestock and Meat Statistics*); p_c^f—average price received by broiler producers, ¢/lb. (USDA, *Poultry and Egg Situation*). Exogenous variables: p_h^f—farm price of corn, $/bu. (USDA, *Agricultural Statistics*); n_p—pigs raised per sow (USDA, *Livestock and Meat Statistics*); n_c—labor productivity index in poultry industry (USDA, *Changes in Farm Production and Efficiency*).

[a, b] See table 1.

[c] See table 2.

Table 6. Identity Relations of Structural Model

Equation	Variables
Price margins (6.1–4)	$s_i = p_i^r - p_i^f$ (for $i = fb, ob, p, c$)
Fed beef supply (6.5)	$q_{fb}^c = q_{fb}^p$
Other beef supply (6.6)	$q_{ob}^c = q_{ob}^p + m_b$
Pork supply (6.7)	$q_p^c = q_p^p + t_p$
Chicken supply (6.8)	$q_c^c = q_c^p + t_c$
Feeder calf inventory (6.9)	$k_{fc} = k_{c-1} - c_{-1} - i_{d-1} + m_c$
Range cattle inventory (6.10)	$k_r = k_{fc} - k_{fb}$

Sources and notes: All variables as defined above with the additional exogenous variables: m_b—imports of beef, m. lb. carcass weight (USDA, *Livestock and Meat Statistics*); t_p—net trade and stock changes of pork, m. lb. carcass weight (USDA, *Livestock and Meat Statistics*); t_c—net trade and stock changes of chicken, m. lb. carcass weight (USDA, *Poultry and Egg Situation*); i_d—replacement dairy heifers 1–2 years, m. (USDA, *Livestock and Meat Statistics*).

changes. In equation (6.9), the number of feeder calves is given by calves surviving plus calf imports less calves slaughtered and dairy herd replacements. Identity (6.10) specifies a residual number of calves available for either beef herd replacements or range feeding for slaughter.

Reduced Form Model

From the estimated structural model, consisting of nineteen stochastic equations and ten identities, a set of reduced form equations describing the endogenous variables in terms of lagged endogenous, exogenous, and error terms are derived. The reduced form equations are employed to evaluate the forecasting properties of the model and to evaluate the time path of effects of a change in one or more of the exogenous variables on the endogenous variables. The procedures followed are described in Goldberger (pp. 364–71).[10]

Prior to examining the model's performance, we first determined its stability and cyclical properties (see Freebairn and Rausser [1973] for further details). The estimated characteristic roots describing the expected time path of the endogenous variables reveal a convergent deterministic system made up of dampened cycles and oscillations. The dominant roots, a pair of complex conjugates, had modulus 0.7697. While lying within the unit circle as required by a convergent dynamic system, the magnitude of the dominant roots indicates that the effects of an exogenous shock to the livestock sector (either from an exogenous variable or from an error term) will extend into several future periods. The nature of relative magnitudes of the other roots, a negative real root −0.6967, a pair of complex conjugates with modulus 0.6487, a pair of complex conjugates with modulus 0.5367, two negative real roots, and a positive root, together with the dominant roots, suggest that at least in the near future dynamic behavior of the system will involve a mixture of cyclical and oscillatory components.[11] These properties refer only to the deterministic aspects of the model, and thus, once we recognize that error terms and variations in the exogenous variable exert significant influences, the dynamic behavior of the system becomes less clear.

Forecasting Properties

In table 7, the actual values of some retail price, farm price, meat production, and livestock inventory variables in 1970, 1971, and 1972 are compared with forecast values of these variables, and approximate estimates of the standard forecast errors are reported for the 1972 forecasts.[12] The years 1970 and 1971 represent a period within the sample set from which the model was estimated, while 1972 represents a period outside the sample set.

[10] Several operating assumptions were invoked to allow treatment of the structural model as a set of linear difference equations. First, the feeder calf price variability variable Vp_{fd}^f, where V denotes the variance operator, is treated as an exogenous variable. Second, the weights used to calculate the price variables p_{on}^r and p_b^r in the demand equations are treated as constants. Finally, the per capita operator P and the deflation operation D are treated as constants for each period and are used to specify the demand equations in terms of aggregate quantities consumed and current value price and income levels.

[11] The dominant complex roots suggest convergent cyclical behavior with an average cycle length of 5.4 years. This point sample estimate lies between the hypothesized internally generated cycles of four years for the pork subsector (Larson) and eight to twelve years for the cattle subsector (Ehrich) and reflects the fact that in our model the simultaneous interaction among the various subsectors is explicitly recognized. Note also that even though in the long run we expect the cyclical elements suggested by the dominant roots to prevail, the different types of computed roots imply patterns of behavior of the endogenous variables in the near future which are less definite.

[12] The approximate nature of the estimates emanate from three sources. The covariance matrix for the structural model parameters was approximated by a block diagonal matrix with all covariances for parameters in different equations set to 0. The predetermined variables have been treated as known constants rather than as random variables. Finally, the estimates are asymptotic estimates rather than small sample estimates.

Table 7. Actual and Forecast Values of Endogenous Variables

	1970		1971		1972		
	Actual	Mean Forecast	Actual	Mean Forecast	Actual	Mean Forecast	Standard Error of Forecast
Retail prices (¢/lb.)							
Choice beef	98.6	101.9	104.3	105.9	113.8	116.1	5.2
Hamburger	66.2	68.3	71.4	71.8	75.4	80.1	2.9
Pork	78.0	71.7	70.3	71.3	83.2	75.3	6.1
Chicken	40.8	40.2	41.0	41.6	41.4	42.9	2.2
Farm prices ($/100 lb.)							
Slaughter steers	29.3	31.6	32.4	32.1	35.8	36.2	2.8
Cull cows	21.3	22.0	21.6	23.2	25.2	26.4	2.4
Hogs	22.0	18.8	18.5	18.4	26.7	24.0	3.5
Chickens	13.6	13.5	13.7	14.1	14.1	14.5	1.3
Feeder calves	36.7	35.9	36.8	35.0	46.5	45.9	4.2
Production (100 m. lb.)							
Fed beef	166.0	165.2	165.5	169.4	204.2	184.2	5.2
Other beef	48.7	51.1	51.4	53.4	47.1	45.1	4.6
Pork	134.4	141.2	147.9	145.3	136.3	141.5	12.6
Chicken	86.7	85.9	87.2	86.2	91.0	92.0	3.1
Inventory (m.)							
Cattle on feed	26.6	27.6	28.9	28.7	29.2	32.2	1.4
Beef cows	37.9	38.0	38.8	39.1	41.1	40.6	0.8
Farrowing sows	14.2	13.4	12.9	13.1	12.7	12.7	1.2

The mean forecasts are relatively close to the observed values, and the actual values for 1972 fall within a 95% confidence interval for the forecasts. Clearly, this evaluation is restrictive and to a large extent peculiar to the three periods. Nevertheless, in terms of forecasting ability, it suggests that the estimated model provides a reasonable representation of observed movements in the endogenous variables describing the livestock sector.

Dynamic Multipliers

Dynamic multipliers describe the incremental effects of a one-period change in the level of an exogenous variable on the time path of values of an endogenous variable (Theil and Boot). Specifically, a period multiplier is given by dy_{t+r}/dx_t, where y_{t+r} denotes an endogenous variable in period $t+r$ with $r = 0, 1, \ldots, \infty$, and x_t denotes an exogenous variable in period t. When $r = 0$, the multiplier is called an impact multiplier describing the current period or short-term effect of a change in x on y. For $r > 0$, the multiplier is called an interim multiplier describing the effect on y in period $t+r$ of a change in x in period t. The equilibrium or long-term multiplier effect of a change in x on y is given by $\sum_{r=0}^{\infty} dy_{t+r}/dx_t$. With respect to these various types of multipliers, our discussion focuses only on expected values. In other words, the random error terms of the reduced form equations are set to 0 and uncertainty about the reduced form parameters is not considered (with one exception discussed later).

Table 8 reports estimates of the effects of a 100-million-pound increase in the level of annual beef imports, e.g., as a result of expanding the meat import quota on retail meat prices, farm livestock prices, domestic meat production levels, and livestock inventory levels. Signs of the dynamic multipliers reflect the estimated parameters of the specified structural model.

The current period effects of a higher level of beef imports are described by the impact multipliers (column 0 of table 8). Greater imports result in an increased supply of other beef, but by less than the increase in beef imports because of a small reduction in the domestic production of other beef. The increased supply of other beef induces lower retail meat prices,

Table 8. Mean Estimates of Multipliers for 100-m.-lb. Increase in Beef Imports

Endogenous Variable	Impact and Interim Multipliers 0	1	2	3	4	Equilibrium Multipliers
Retail Prices (¢/lb.)						
Choice beef	−0.4941	−0.1089	0.2647	−0.3328	0.0141	−0.6548
Hamburger	−0.5518	−0.4358	−0.0508	0.0146	−0.1045	−1.1451
Pork	−0.0927	−0.1965	0.2005	0.2471	−0.4486	−0.1011
Chicken	−0.1286	−0.0282	0.0637	−0.0480	−0.3372	−0.1545
Farm Prices ($/100 lb.)						
Slaughter steers	−0.2810	0.0055	0.1492	−0.2251	0.0620	−0.3003
Cull cows	−0.4705	−0.0001	−0.0432	0.0466	−0.1259	−0.5456
Hogs	−0.0547	−0.1003	0.1467	0.0400	−0.2941	−0.0464
Chickens	−0.0735	−0.0061	0.0372	−0.0325	−0.0148	−0.0776
Feeder calves	−0.3433	−0.1217	0.0793	−0.1704	−0.0395	−0.5779
Production (100 m. lb.)						
Fed beef	0	−0.3105	−0.4369	0.3498	−0.0067	−0.4816
Other beef	−0.2315	0.4185	−0.0634	0.2360	−0.0137	0.4031
Pork	−0.2608	0.2143	−0.2113	−0.6481	0.7953	−0.4478
Chicken	0	−0.0608	−0.0051	0.0308	−0.0296	−0.0642
Inventory (m.)						
Cattle on feed	−0.0489	−0.0688	0.0551	−0.0011	−0.0066	−0.0758
Beef cows	0.0544	0.0149	0.0269	−0.0010	0.0093	0.0906
Farrowing sows	0.0036	−0.0418	−0.0196	0.0610	−0.0298	−0.0309

particularly for hamburger and to a lesser extent for choice beef, and lower livestock prices, particularly for cull cows and to a lesser extent for choice slaughter steers and for feeder calves. The lower livestock prices induce producers to place less cattle in feedlots, to retain more sows for the relatively more attractive hog activity, and to increase the inventory of beef cows. The latter outcome is explained upon inspection of the estimated beef inventory in equation (3.4). Lower prices for feeder calves reduce the incentive for retaining cows, but lower prices for cull cows reduce the salvage value of cull cows, and the second influence is relatively more important in producers' decision to retain cows for breeding. Moreover, the current period effects of increased beef imports on livestock prices and on livestock inventory decisions influence the performance of the livestock sector in subsequent years.

The subsequent period effects of a higher level of beef imports are described by the interim multipliers (cols. 1–4 of table 8). Comparing the relative magnitudes of the impact and interim multipliers, the second and subsequent period effects are important, and the level of importance declines over time. Signs of the interim multipliers indicate a complex process of adjustment of prices, production, and inventory levels. Price changes influence inventory decisions which largely determine production levels and prices in the next period, and in turn, prices influence inventory levels. Summing the interim multipliers over time to obtain cumulative multipliers reinforces the initial multiplier effects on the cattle sector.

Long-run effects of an increase in beef imports are described by the equilibrium multipliers of table 8. All prices are lowered, particularly for these products competing directly against imported beef. Domestic meat production levels are lowered for all the meats, except that of other beef. Livestock inventory levels fall for cattle placed in feedlots and for farrowing sows but increase for beef cows.

The result that beef cow numbers increase as a result of more beef imports is an unexpected result and one which has a critical influence on the other multipliers; in part, it explains the increase in production of other beef and the associated price-depressing effect of the extra production. Inspection of the structural equation for beef cow inventory, equation (3.4), together with the equilibrium multipliers for the prices of feeder calves and

cull cows, suggests that the lower prices induce producers to lower the cow culling rate because of the relatively small opportunity returns for cull cows. While there are technological lower bounds to the culling rate, it is doubtful if the culling rate during the sample period was at the minimum rate. Perhaps a more important qualification is that the equilibrium multipliers are sensitive to values of the parameters on the cull cow price and the expected feeder calf price variables in equation (3.4). For example, the equilibrium multiplier for the inventory of beef cows decreases as the parameter on the feeder calf price is increased and the parameter on the cull cow price is decreased (reflecting the relatively more important role for feeder calf prices in producers' decisions to retain cows).[13] Note that this equilibrium multipler is close to 0 for parameter changes of 15%. Further, parameter changes of this magnitude are less than one standard error of the parameter estimates. Thus, while the estimate of the expected value of the long-term multiplier for the number of beef cows with respect to beef imports is positive, the estimate may not be sufficiently precise to reject the hypothesis of a negative multiplier.

[13] The coefficient changes have implications also for the other equilibrium multipliers. In particular, because of the lower beef cow inventory level, the production of other beef becomes smaller, and this has the effect of reducing the extent to which prices decline.

Implications

Returning to the theme of our introductory comments, table 9 collates the expected effects of a 200- and a 700-million-pound increase in the annual level of beef imports on variables influencing the welfare of consumers, welfare of beef producers, and variables describing growth of the cattle industry. These levels of beef imports are chosen for examination since during the period of producer agitation for beef import restraints, annual imports increased by 900 million pounds between 1960 and 1963, and between 1963 and 1965, imports fell by 700 million pounds. Comparing 1971 and 1972 and recalling that import quotas were relaxed in 1972, beef imports increased by 200 million pounds. Moreover, Jackson has estimated "that removal of the quota in 1975 would lead to increased imports of the magnitude of 670 million pounds" (p. 2).

The estimates in table 9 suggest that actual changes in the annual levels of beef imports since 1960 have had a modest influence on performance of the U.S. livestock sector and that this picture is unlikely to change in the near future. In terms of consumer welfare, beef imports reduce the retail price of all the meats with the larger reductions occurring for the lower quality manufacturing beef products. Given that manufacturing beef is a relatively more important component of the ex-

Table 9. Estimated Effects of a 200- and 700-m.-lb. Increase in Beef Imports on Some Endogenous Variables

		Increase in Beef Imports (m. lb.)[a]			
		200		700	
Endogenous Variable	1972 Levels	Current Year	Long Term	Current Year	Long Term
Retail Prices (¢/lb.)					
Choice beef	113.8	−0.99	−1.31	−3.47	−4.59
Hamburger	74.4	−1.10	−2.29	−3.85	−8.02
Pork	83.2	−0.19	−0.20	−0.67	−0.70
Chicken	41.4	−0.26	−0.31	−0.91	−1.09
Farm Prices ($/100 lb.)					
Slaughter steers	35.83	−0.56	−0.60	−1.96	−2.10
Cull cows	25.21	−0.94	−1.09	−3.29	−3.82
Feeder calves	46.54	−0.69	−1.16	−2.42	−2.42
Inventory (m.)					
Cattle on feed	29.16	−0.10	−0.15	−0.34	−0.53
Beef cows	41.10	0.11	0.18	0.38	0.63

[a] 1972 level of 1996 m. lb.

penditures of low income households (USDA 1965), higher import levels may be considered to have favorable redistributional effects. Still, a 700-million-pound increase in annual beef imports would reduce hamburger prices by less than 10%. Turning to livestock prices, increased beef imports reduce slaughter steer, cull cow, and feeder calf prices. The price falls place a heavier burden on cattle breeders relative to cattle feeders. Part of the reduction in the returns for the output of cattle-feeding activities is offset by a larger fall in the price of the input feeder calves. For the cattle breeder, returns from both feeder calves and farm cull cows fall. As argued by Jackson, a large portion of the burden of lower cattle prices associated with increased imports likely will fall on values of the inelastic supply of ranching real estate used for cattle breeding. The results also suggest that higher beef import levels cause a small decline in the number of cattle placed in feedlots and a small increase in the number of beef cows, with the latter being associated with a lower cow culling rate due to the reduced opportunity return from selling cows for slaughter relative to retaining them to breed calves.

Finally, it is worth noting the conditional nature of the foregoing policy analysis. In particular, the results are influenced by the underlying logic of the specified model of the U.S. livestock sector, and the estimates of table 9 refer only to expected effects and thus are subject to sample errors.

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Notes

The Measurement of Price Elasticities in International Trade

Peter Tryfos

In many econometric studies of the effect of price changes on the quantity of a commodity exported, a relationship is assumed essentially of the following form:

$$(1) \qquad Q_1 = \alpha + \beta(P_1 - P_2) + u,$$

where Q_1 denotes the quantity exported, P is the current price, u is an error term, and the subscripts denote two different countries or regions. Houthakker and Magee, for example, use a logarithmic version of equation (1) with an additional term representing world income to estimate the price elasticity of U.S. agricultural exports in world trade; Kulshreshtha and Wilson use a similar expression to estimate the export demand of Canadian beef.[1]

Equation (1), often called an "export demand" function, has an intuitive appeal. Other things being equal, country 1 will export when the difference in prices, $P_1 - P_2$, is negative; the greater the price difference, the larger the volume of exports. Similarly, imports will take place when the price difference is positive. Thus, the sign of β in equation (1) can be expected to be negative.

Unfortunately, reasonable as such a simple model may appear, it is not often estimable. Given the nature of the available data and conditions typically prevailing in international trade, the estimates of the price elasticities obtained are not only unreliable but are often biased and may be potentially dangerous as a basis for policy decisions.[2]

This note is a case study of the response of exports or imports to price changes in international trade. After a brief discussion on the nature of a principal error, we draw upon an econometric model of the Canadian livestock-meat industry to demonstrate the magnitude of the error as it relates to the trade in meat between Canada and the United States.

Export Demand Functions

Let us assume that initially demand and supply in countries 1 and 2 are in equilibrium, equilibrium prices (expressed in a common currency) are identical, and the entire supply is consumed in the domestic markets. As a result of a change in the domestic demand or supply in country 2, we assume the price in 2 is increased. In order to take advantage of profitable arbitrage opportunities, some of country 1's supply will be exported to 2 as equation (1) suggests. As a consequence of this flow, however, the price in 1 will increase while the price in 2 will decline. The quantity exported from 1 to 2 will be just enough to bring about an equality of prices at a new level. Similarly, a temporary increase in the price in country 1 will lead to imports from 2, as a result of which the prices will again be equalized.[3]

The question is whether it is possible to estimate an export demand function using the recorded (historical) exports or imports and price differences (usually, based on average prices per period of time).

If the adjustment in prices described above can be completed within a period of time shorter than the one to which the available data refer, then clearly the recorded exports or imports and price differences will have no relationship to each other. A zero price difference may be associated with any quantity of exports or imports because the recorded price difference does not reveal the actual difference which gave rise to the observed exports or imports.

If the adjustment takes longer than the period to which the available data refer, the observed exports or imports are related, in part or entirely, to past price differences. It should be borne in mind, how-

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[1] Equation (1) appears in many versions in the literature; frequently, the logarithmic version, $\log Q_1 = \alpha + \beta \log (P_1/P_2) + u$, is used; the dependent variable is often Q_1/Q_2; income or relative income may appear as an additional explanatory variable; it is often used to estimate imports with suitable adjustments to the right-hand side; the two countries may be competitors for the imports of a third country or region, etc. For some other recent studies, see Adler, Detomasi, and Richardson.

For reasons not explained, Kulshreshtha and Wilson include the Canadian price of beef as an additional explanatory variable.

[2] The statistical validity of equation (1) was questioned by Orcutt and by Malinvaud among others. Some authors, Richardson, for example, attempt to improve the estimates by more careful use of price and other data. The inadequacy of recorded prices in reflecting the price differentials which give rise to exports and imports was earlier discussed by Stern and Zupick.

[3] Changes in demand and supply schedules may be due to other variables. The effect of tariffs and transportation costs is to create a range around the prevailing price such that no flows occur for price variations within this range; these effects tend to disappear when prices are averaged over long time periods.

ever, that empirical investigations have traditionally focused on relatively long time periods. Typically, it is annual exports or imports which are investigated, while data for shorter periods of time are seldom utilized. Therefore, when relatively long periods of time are used, little correlation should exist between recorded price differences and exports or imports. If a statistical model such as equation (1) is used, the estimate of the effect of a price change, $\hat{\beta}$ in equation (1), is as likely to be positive as negative.

Unfortunately, an economist's bias may be more serious than any statistical bias. Since the effect is expected to be negative, a positive estimate is sometimes considered "wrong" (e.g., Houthakker and Magee, p. 112) and the model is manipulated so that the "inconsistent" estimates disappear. Thus, because perfectly reasonable results are dismissed and "consistent" results are selectively presented, a bias is introduced in favor of negative estimates when, in fact, available data do not allow any estimates to be made.

Price Elasticities from Demand and Supply Estimates

The price elasticity of a country's exports can be obtained from the net export function defined as the difference between the domestic supply, $S(P)$, and demand, $D(P)$, functions:

$$E(P) = S(P) - D(P), \tag{2}$$

which expresses the quantity exported ($E > 0$) or imported ($E < 0$) as a function of the prevailing international price (cf., Orcutt). The net export function is estimable if the demand and supply functions are estimable.

In the case of Canada, the large difference in the sizes of Canadian and U.S. markets allows us to treat prices in Canada as determined by U.S. prices and to estimate separately Canadian demand and supply functions for meat. Thus, Canadian net export functions can be written as the difference between the domestic supply and demand functions. The price elasticity of meat exports so calculated can be compared with estimates obtained from equation (1).

Demand and supply functions are estimated within the framework of a model of the Canadian livestock-meat industry. This model is a system of simultaneous linear equations forming a nearly block recursive system in which the three blocks deal with demand, supply, and prices and employment, respectively. The parameters of the system were estimated by applying the estimation procedure appropriate for each block separately. These block estimates for all four industry commodities (cattle/beef, pigs/pork, calves/veal, and lambs/lamb meat) and a lengthier justification of the model equations were published earlier: the demand equations were discussed in Tryfos and Tryphonopoulos, the supply equations were presented in Tryfos (1974a), and the price and employment equations were presented in Tryfos (1973). In order to keep the industry model within convenient size, only the two principal industry commodities (cattle/beef and pigs/pork) were considered. Thus, with minor modifications from each set of estimates, those referring to cattle or beef and pigs or pork are used. The complete model can be found in Tryfos (1974b) and in a lengthier version of this paper available from the author on request.

In this model of the Canadian livestock-meat industry, the two net exports functions are expressed as identities in the form of equation (2): for each principal industry commodity, net exports is the difference between the domestic demand and the domestic supply. Net exports of livestock and of meat are combined by converting livestock into the corresponding meat equivalent quantity. If, at prices ultimately determined in the U.S. market, the domestic (Canadian) supply exceeds domestic demand, the surplus is exported; if, on the other hand, domestic supply is not sufficient to meet domestic demand, the deficit is imported.

Of special interest here are the implied elasticities of Canadian net exports with respect to livestock prices in the United States shown in table 1. Other things being equal, a rise in the price of cattle (expressed in Canadian dollars) in the United States by 1% is expected to increase Canada's net exports of beef by about 4% and to reduce the net exports of pork by about 2%. Similarly, a rise in the price of hogs in the United States by 1% can be expected to result in a reduction of net exports of beef by about 0.5% and in an increase of net exports of pork by about 4%.

Price Elasticities from Regressions on Price Differences

The estimates of two regression equations of net exports against price differences are shown in table 2; Q_c denotes Canadian net exports, P_c is the Canadian live animal price, and P_u is the live animal price in the United States expressed in Canadian dollars.

The coefficients of the price difference terms are both negative, as would be expected under equation (1). However, the coefficients are not significantly different from zero, and the fit of the estimated equation is very poor as indicated by the low R^2. The

Table 1. Export Elasticities

Canadian Net Exports	Elasticity with Respect to U.S. Cattle Price (in $ Can.)	Elasticity with Respect to U.S. Hog Price (in $ Can.)
Beef	4.13	−0.52
Pork	−1.98	4.02

Note: Estimates are based on annual observations for the period 1956–70.

Table 2. Regression Results for $Q_c = \alpha + \beta(P_c - P_u) + u$

Net Exports (Q_c)	Constant	Price-Difference ($P_c - P_u$)	R^2	d
Beef	1.861	−0.055	0.02	1.32
	(2.86)	(−0.61)		
Pork	10.917	−0.033	0.05	1.67
	(7.08)	(−0.89)		

Note: Numbers in parentheses are t-values; d is the Durbin-Watson statistic. Estimates are based on annual observations for the period 1956–70.

implied elasticities with respect to price differences at the point of means of the variables are −0.24 for beef exports and +0.00 for pork exports.

Conclusion

The case study appears to confirm the proposition that recorded differences in the price levels between countries do not reflect the price differences which were the cause of the recorded exports and imports, if the time period to which the data refer is relatively long. Clearly if equation (1) is used as the model for the measurement of the price elasticity of Canadian meat exports, the estimates would be misleading and potentially dangerous for policy decisions.

In general, the applicability of equation (1) or of similar models for measuring the reaction of a country's exports or imports to changes in relative prices is severely restricted. Required are relatively long adjustment lags and relatively short time periods to which the data refer. Not only is there doubt that available data are suitable for measuring the response to price changes for specific commodities, but additional doubt is cast by the aggregation of commodities with dissimilar demand and supply characteristics into broad categories (manufacturing, agricultural, raw materials) by the use of price indexes and by the substitution of value-derived quantity indexes for specific measures of quantity. It is not surprising, then, that estimates of price elasticities from such studies are not precise; what is surprising, however, is the expectation that these estimates be of a given sign and the rejection of estimates of the opposite sign as "inconsistent" with theory.

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The Exchange Rate and U.S. Agriculture: Comment

Amalia Vellianitis-Fidas

In a recent article Schuh states "that a very important variable has been left out in the conception of this [farm] problem and that at least since the early or mid-1950's the definition of the problem has been at least partially wrong because of this omission. The omitted variable is the exchange rate and its role in trade, in the valuation of resources within the U. S. economy, in the distribution of benefits of economic progress between consumers and producers within an economy, and in the way the benefits of technical change are shared between the domestic population and the world at large" (pp. 1–2). The suggestion that an overvalued dollar has been a "missing link" in a viable explanation of events taking place in agriculture in the past twenty years is sufficiently novel and far-reaching that it deserves greater analytical discussion than offered in Schuh's article.

The first and central hypothesis presented in Schuh's article is "that an important share of the income problems of U. S. agriculture in the post-World War II period was a result of the persistent over-valuation of the U. S. dollar, which resulted in an *under*-valuation of our agricultural resources in relation to their world opportunity costs" (p. 2). This statement is the author's most important hypothesis because other arguments are based heavily on it. However, little evidence is offered in support of this hypothesis, and what is offered is a strained interpretation of exchange rate and balance of payments theory. The principal evidence consists of data on the acreage used for producing agricultural exports. These data indicate that the acreage used for producing crops for export declined by 39% between 1951 and 1952 (from 59 to 36 million acres) and declined in 1953 "even further, to little more than half what it had been in 1951 [to 31 million acres]" (p. 5). The author concedes that "although considerably less than an ideal indicator, this data series suggests that as far as agriculture was concerned, the dollar began to be over-valued in 1952" (p. 5). Not only is it less than an ideal indicator, it is not really related to the fundamental issues of the balance of payments and the exchange rate of a country.

In gauging whether a country's currency is overvalued or undervalued, it is essential to consider a country's balance of payments position. The use of acreage for exports as an indicator of exchange rate equilibrium shows that the balance of payments is being considered on a section basis.[1] Over time, some sections of the balance of payments will usually be positive or negative. For example, foreign aid entries would always be negative since the United States is not a recipient but a donor of aid. When a country's balance of payments is negative, it is tempting to think that one particular section, such as foreign aid, is responsible. Therefore, the argument goes, by eliminating bilateral foreign aid the country's deficit would be eliminated or greatly diminished. This is highly doubtful. The various parts of the balance of payments are interrelated. Forced improvement in one part may be at the expense of another part. An assessment of the balance of payments situation of a country is done in toto and a country's monetary and exchange rate policy is concerned only with its overall balance of payments, not with any section and certainly not with any one sector, such as agriculture in that section.

In general, an exchange rate reflects the country's economic conditions and the purchasing power of one currency versus another. Even at a time of generally fixed exchange rates under the International Monetary Fund Charter when theoretically rates could not be changed except under extreme conditions, the underlying determinant of an exchange rate is and has been the supply and demand for that currency. In the early 1950s, demand and the desire to hold dollars as freely convertible currency was at an all-time high. The statement that the dollar was overvalued as early as 1952 is equivalent to the statement that the demand to exchange foreign currencies for dollars was less than the supply of dollars and therefore the exchange rate was in disequilibrium. To the contrary, in this early postwar period, demand for the dollar was so high that the international monetary problem of the 1950s was a "dollar shortage," the direct opposite of the proposed overvalued dollar. In fact, several books were written suggesting remedies to correct the U.S. surplus balance of trade position (Kindleberger 1950, MacDougall, Zupnick, Hoffmeyer).

An additional point on the use of acreage alloted for exports as an indicator of a dollar overvaluation should be made. According to this same data, if the average acreage alloted for exports is calculated for the twelve years before 1952 (1940–51), it is 34.5 million acres whereas for the twelve years after, it

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[1] The balance of payments consists of a currency account (basically exports and imports of goods and services), a capital account (aid, private remittances, inflows and outflows of long-term capital, and private short-term capital flows), and an official reserves section used for financing imbalances in the first two sections.

is 53.2 million, a 54% increase. Thus, all the reader is left with to substantiate the hypothesis that the dollar was overvalued since 1952 is a downturn in acreage alloted for exports in 1952 and 1953.

"Complementary data which support that argument [that the dollar was overvalued] and which suggest a persistent over-valuation throughout the rest of the 1950's and the 1960's are [also] provided" (p. 5). This evidence consists of U.S. gold stocks from 1940 and 1970 and the observation that the U.S. gold stocks began a secular decline after 1952. While this evidence avoids the pitfalls of determining the existence of a dollar overvaluation by looking at an individual sector, it has other shortcomings. First, the data presented offer an incomplete picture of the United States and world gold stock situation, because the time span used is misleading and because no explicit connection is made between variations in the gold stock and the condition of the dollar vis-à-vis other currencies. The years since 1940 represent a period of unusual growth in U.S. gold stocks. There are only two ways that a country's gold stocks can grow: by running trade surpluses with other countries to the extent that those countries choose to pay their deficits with gold rather than with some other international reserve currency or by possessing within its borders gold-producing mines.[2]

With these two ways in mind, a close look at the record of U.S. gold stocks, as well as stocks of the other major holders of gold presents quite a different picture and conclusion than the one presented by Schuh. Gold stocks increased after 1940 because Europe experienced the greatest devastation of its economy and sold much of its gold to obtain materials needed for waging war and later rebuilding its economy. During the 1940–50 period, the United States was the only economy capable of supplying strategic and nonstrategic goods to Europe. An examination of the data on European gold stocks strongly suggests that the tremendous rise in U.S. gold during this period was a reflection of the purchase of goods with gold (table 1) by Europe. The decrease in gold stocks after the early 1950s was more an indication of the rebuilding of Europe and Japan, not a downturn in the international economy of the United States.

The balance of payments on an official settlements basis is a more pertinent indicator than crop acreage devoted to exports or gold stocks (table 2). However, there is no analysis of this variable either other than the indication that from 1950 to 1971, the balance of payments (on an official settlements basis from 1940 to 1963 and on a liquidity basis from 1964 to 1971) was in deficit "almost perpetually . . . from 1950 through 1971" (Schuh, p. 5). In order to determine when a country's exchange rate reaches a basic disequilibrium vis-à-vis other currencies, many factors need to be considered. First, the amount and duration of a country's balance of payments deficit is limited by the size of its international reserves, its ability to borrow, and the limits to which other countries will hold its currency as a reserve currency. Since the U.S. dollar was the most important and universally accepted international reserve currency in the 1950s, other countries were quite willing to accumulate dollars for U.S. liabilities. These dollars increased their depleted foreign exchange holdings.

At what point, then, can we say that the United States reached its deficit limits and should have

[2] Gold is part of the official reserves section in the balance of payments and is used to compensate for imbalances in the other sections of the balance of payments. See note 1.

Table 1. Gold Holdings of International Institutions, Central Banks and Treasuries, and Other Governmental Institutions at End of Period

Europe	1937	1938	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
					($ million)								
Sterling area													
United Kingdom	4,141	2,877	1,605	1,350	2,900	2,200	1,500	2,300	2,550	2,050	1,800	1,600	2,850
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1
Ireland	—	10	17	17	17	18	18	18	18	18	18	18	18
Other areas													
Belgium	826	780	624	698	587	635	704	776	778	928	925	915	1,270
Denmark	54	53	32	32	32	31							
Finland	26	26	6	6	12	26	26	26	31	35	35	35	35
France	2,749	2,757	548	523	523	597	582	617	708	942	924	581	750
Greece	24	27	6	6	4	4	10	11	11	11	10	13	17
Italy	210	193	112	256	256	333	346	346	346	352	338	452	1,086
Netherlands	933	998	167	195	311	316	544	737	796	865	844	744	1,050
Norway	74	84	53	51	50	50	50	52	44	45	50	45	43
Portugal	80	86	236	178	192	264	286	361	429	428	448	461	493
Spain	718	525	111	85	61	51	127	130	132	132	132	101	57
Sweden	244	321	81	70	90	152	184	219	265	276	266	219	204
Switzerland	650	701	1,387	1,504	1,470	1,451	1,411	1,458	1,513	1,597	1,664	1,706	1,925
Turkey	29	29	162	154	150	151	143	143	143	144	144	144	144

Source: International Monetary Fund.

Table 2. U.S. Balance of Payments (in $ million)

1940	2,890	1960	−3,711
1941	1,119	1961	−2,370
1942	−206	1962	−2,203
1943	−1,979	1963	−2,670
1944	−1,828	1964	−2,800
1945	−2,737	1965	−1,335
1946	+1,261	1966	−1,357
1947	+4,544	1967	−3,544
1948	+1,006	1968	172
1949	+211	1969	−6,958
1950	−3,489	1970	−4,271
1951	−395	1971	−23,977
1952	−1,080		
1953	−2,102		
1954	−1,516		
1955	−1,242		
1956	−995		
1957	+432		
1958	−3,529		
1959	−3,743		

Source: Schuh, p. 6.

devalued? Some economists believe that there is no limit to the balance of payments disequilibrium the U.S. dollar could maintain because of its role as a reserve currency and the role of the United States as a financial intermediary. "It must be recognized that trading in financial assets with the United States means a United States deficit; United States capital provided not only goods and services, but liquid assets to Euorpe which means European acquisition of dollars" (Despres, Kindleberger, and Salant, p. 49). Edward M. Bernstein, an international monetary economist took a more middle-of-the-road position in 1966: "The pragmatic test of a deficit is whether the balance of payments could be continued indefinitely with the existing relationship of the accounts [i.e., with the existing deficits and surpluses in different sections of the balance of payments]" (p. 54).

It is more reasonable to suggest that the United States was able to continue running deficits because other countries were allowing it to do so, so that they could acquire external liquidity. This very process eventually helped undermine confidence in the dollar, but it is difficult to detect which came first, the resupplying of European economies to an adequate liquidity level and thus a diminishing lack of interest in continuing to build dollar reserves or a lack of confidence in the dollar because it reflected a basic balance of payments disequilibrium. Two indications of a basic balance of payments disequilibrium may be when countries actually began demanding gold for U.S. liabilities in great quantities beginning about 1959. There are other explanations for the gradual erosion of the dollar after 1959, including the tremendous expenditures caused by the Vietnam War. Once other considerations are analyzed, such as preferences for gold rather than dollars, the long-run balance of payments position, long-run terms of trade, external price trends versus international price trends, the final issue becomes one of confidence in a particular currency vis-à-vis other currencies at a particular point in time. No evidence is presented in the article or by the extensive literature on the role of the dollar in 1950s that a lack of confidence in the dollar existed as early as 1952.[3]

Schuh's second major hypothesis is "that the sizeable devaluations of the last two years and the movement to essentially flexible exchange rates constitute important structural changes for U. S. agriculture and the U. S. economy" (p. 2). This hypothesis has two corollaries stemming from the first hypothesis: "that the stress caused by this under-valuation [because of the over-valuation of the dollar of our agricultural resources] forced a more rapid rate of technical change than would otherwise have been obtained" and that "the over-valuation of the dollar resulted in a larger share of the benefits from the technical change being channeled to U. S. consumers than would have occurred with an equilibrium exchange rate" (p. 2). Underlying this hypothesis and its corollaries is an assumption that a dollar devaluation would have significant effects on U.S. agricultural exports and U.S. agriculture as a whole. More specifically this second hypothesis implies a common but unproven assumption: that the devaluation of the dollar in 1971 and 1973 resulted in a substantial increase in agricultural exports from the United States and an increase in domestic prices of these products as total demand (domestic plus foreign) for U.S. agricultural products shifted upward in terms of dollars. This assumption is not only unproven, but the evidence is to the contrary. The author's case is that "the combined effect of the U.S. devaluations and the currency realignments has been to place considerable upward pressure on the price of tradeable products . . . viewed domestically. . . . The devaluation . . . sets forces into play which lead to a bidding up of their [export] prices" (p. 10). The devaluation has made U.S. agricultural imports more expensive and will thus make substitute goods more expensive. "The effect of the devaluation will tend to spread throughout the sector, with higher feed grain prices, for example, raising the cost structure of the livestock sector" (p. 11).

Furthermore, at least part of the recent rise in food prices is attributed to the currency realignments, and agricultural prices are cited as an important contributor to inflation. Schuh concludes that "an important share of the rise in agricultural prices in mid-1973 is a result of monetary phenomena which induced an export boom in an economy that was already responding to expansive monetary policies, and in the case of agriculture, increased the foreign demand for U. S. output at the same

[3] Charles P. Kindleberger places the date of dollar overvaluation not before 1968 (1974, p. 22). Paul Samuelson's opinion is that the dollar was overvalued by 1960 (p. 116).

time that this demand was already rising from temporarily bad weather conditions in other countries and a temporary decline in the Peruvian fishmeal industry" (p. 12).

Recently this writer has described results of two quantitative studies that measure the effect of exchange rate changes on U.S. agricultural exports (Vellianitis-Fidas). The results indicate that the exchange rate changes were not significant explanatory variables for U.S. exports of wheat, corn, or soybeans in the 1971–73 period nor were exchange rate changes by other countries in the 1960–69 period significant in explaining the variation in U.S. exports of wheat, corn, cotton, tobacco, and oilseeds. These results are consistent with the conditions inherent in the agricultural sector; that is, the general inelasticity of agricultural export supplies, particularly in the short run, prevents shifts of the export demand curve (caused by a devaluation) from resulting in very great changes in quantity. Empirical evidence indicated that the shift in demand that could be attributed to the exchange rate changes was quite small and could not have helped bid up agricultural prices.

Institutional factors, such as the provisions of the Common Agricultural Policy of the European Community which automatically impose a levy on some imported commodities, particularly grains, prevented the full impact of the devaluations from manifesting themselves in demand shifts for U.S. agricultural exports. My research also indicated that the changes in import quantity or value of imports demanded from the United States or from the rest of the world attributable to changes in the exchange rate of other countries were also quite small. This could be explained by the generally accepted idea that the demand for agricultural exports is very price inelastic. The small shift in supply available for import by a devaluing country might have worked with the inelasticity of demand to prevent a significant change in quantity or dollar value imported from the United States or from the world after a devaluation or revaluation. Theoretically as well as empirically, the impact of a devaluation or revaluation on agricultural trade should be quite small.

In conclusion, the analysis of the relationship between the events of the past twenty years in agriculture and the value of the dollar presented in Schuh's article is not convincing. Quantitative analyses, as well as the theory of exchange rates applied specifically to the conditions inherent in agriculture, strongly indicate that the effect of exchange rate changes on U.S. exports and therefore on domestic prices of traded agricultural goods, is at most minimal. The proposition that the exchange rate variable has been an important omitted variable in explaining "the farm problem" lacks strength without the support of the two major hypotheses or the two corollaries, and the results presented in this comment indicate that neither hypothesis withstand close scrutiny.

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The Exchange Rate and U.S. Agriculture: Reply

G. Edward Schuh

In her comment, Vellianitis-Fidas makes three points: (*a*) that I offered little evidence in support of the central thesis of my paper and that what she construes as my main evidence constitutes a strained interpretation of exchange rate and balance of payments theory; (*b*) that the persistent deficit in the U.S. balance of payments was because the dollar was a major reserve currency and does not indicate that the dollar was overvalued; and (*c*) that even if the dollar was overvalued it would not have mattered since in her view the exchange rate has no effect. In reply, I focus on these three main issues rather than comment in a detailed way on particular statements. Her paper has numerous inaccuracies, such as "The years since 1940 represent a period of unusual growth in U.S. gold stocks." To deal with all of them would require too much space and probably contribute little to the central thrust of the debate.

To the charge that I offered little evidence (which appears to mean empirical evidence) in support of my central hypothesis, I plead guilty. My paper was an exercise in analysis and an appeal to the logic of the situation. An important goal, in fact, was to suggest hypotheses which might help us better understand our own economic history. Explicit statements of these qualifications were made twice in the original paper: (*a*) at the beginning where it was stated that "this paper is for the most part an exercise in analysis, and its major propositions are offered in large part as hypotheses to be tested with further research" (p. 2), and (*b*) again at the end where it was stated that "both space and time limitations have precluded a systematic parametric analysis of the agricultural sector in the present paper" (p. 12). It should be noted that despite charging me with offering little evidence in support of my hypotheses, Vellianitis-Fidas also provides no evidence. Her paper consists largely of *ad hominem* assertions and selected appeals to authority.

Vellianitis-Fidas's allegation that the principal evidence I offer in support of my hypothesis "consists of data on the acreage used for producing agricultural exports" is a straw man and hardly does justice to the central argument of my paper. Moreover, it is more than a bit strained to say "Thus all the reader is left with to substantiate the hypothesis that the dollar was overvalued since 1952 is a downturn in acreage alloted for exports in 1952 and 1953."

The maintained hypotheses of my paper are that the overvaluation of the dollar had played an important, albeit neglected, role in shaping the course of U.S. agricultural development in the post-World War II period; that its influence had been exerted in part by making U.S. exports less competitive in world markets than they would have been in the absence of the overvaluation; and that consequently domestic prices of agricultural products were lower than they would have been in the absence of such overvaluation. Another part of the argument, of course, is that the restraint in fiscal and monetary policy which was pursued out of concern with the persistent balance of payments problem acted to aggravate what would have in any case been a serious adjustment problem.

Given that the analysis was concerned with agriculture, it seemed reasonable to examine what had happened historically to agricultural exports and to relate data on this variable to the various policy responses of the government and to admittedly superficial evidence, such as the gold outflow and balance of payments deficits, on when the overvaluation might have begun. My discussion of the data on the acreage used for producing agricultural exports was introduced with the statement, "Although *considerably less* than an ideal indicator . . ." (p. 5, italics added). That particular data series was used, as indicated explicitly in the text, as a proxy for exports. It was deemed relevant because the overvaluation of the dollar was hypothesized to have affected exports. Since a major share of U.S. exports are crops, exports expressed on an "acreage" basis facilitated a comparison with the acreage planted to crops in order to show the relative effect.

Vellianitis-Fidas's belaboring of her straw man and an elementary discussion of balance of payments theory is followed by a rather poorly put case that, contrary to my maintained hypothesis, the dollar was not overvalued since in her view we had to run a deficit on the balance of payments in order to fulfill our role as supplier of one of the major reserve currencies in the world. That argument, which appears with frequency in the literature, helps us to understand why the dollar was overvalued; it does not deny that it was overvalued. Moreover, if the dollar was maintained at an overvalued level, clearly the "price" had to be paid someplace, such as in a persistent trade deficit.

The Subcommittee on International Exchange and Payments of the Joint Economic Committee of Congress commissioned a series of studies in the early 1960s on factors affecting the U.S. bal-

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ance of payments (U.S. Congress). A number of the authors of these studies agreed that the dollar was overvalued even at that early date. For example, Vanek (p. 274) makes the judgment, based in part on other research of his, that the dollar was overvalued by approximately 15% at that time. Houthakker, using purchasing power parity theory and data for conditions as of March 1962, comes to a similar conclusion and suggests that a dollar devaluation of about 15% would have been sufficient to restore international equilibrium in the long run. Houthakker traces the cause of the overvaluation of the dollar to the series of devaluations of European currencies undertaken in September 1949 which, in the case of the pound sterling, the guilder, and other major currencies, amounted to about 30%. In his view the true cost conditions remained hidden until the mid-1950s because Europe and Japan were still recovering from the war, so that delivery times were long and prices sometimes meaningless.[1] Moreover, he argues that these were the reasons for the so-called "dollar shortage," which disappeared as soon as peacetime conditions were restored.

To emphasize, as Vellianitis-Fidas does, the role of the dollar as a reserve currency is to miss the point. Clearly, alternative institutional arrangements could have provided international liquidity for the expansion of trade; there was no imperative that the dollar fulfill this role. And had these alternative institutions been available, the U.S. dollar might not have been so persistently overvalued, and the course of development both at home and abroad might have been quite different. U.S. foreign economic policies and military programs had to be adjusted to fit balance of payments requirements, as any student of the period will attest. Similarly, we constrained our own growth, ran higher levels of unemployment than would have been necessary with an equilibrium exchange rate, and limited and otherwise restricted our foreign aid.

The United States obviously reaped some gains from the particular policies followed. For example, we reaped seigniorage gains as an emitter of part of the money supply for the world. And the overvalued dollar helped us to buy up foreign companies around the world and establish a foreign presence.

But the rest of the world benefitted as well. There was a larger transfer of American capital into Europe, which augmented the growth rate there—probably at the expense of ours. With the capital went our more advanced technology and some of our entrepreneurial talent. And what better way for Western Europe and Japan to compete against our superior technology than to keep the dollar overvalued and their currencies undervalued? The decision to be overvalued was not a unilateral decision by the United States. Other countries could have revalued their currencies, and in some cases did, albeit weakly. For the most part they were reluctant to do so, however, despite our urgings, and they were equally as reluctant to reform the international monetary system so that a new source of liquidity could be supplied. In the final analysis, the United States was forced to act unilaterally.

The third main point of the Vellianitis-Fidas paper is to argue, in essence, that even if the dollar had been overvalued, it would not have mattered, since changes in exchange rates do not have any effect. As evidence for this she cites some research of her own. Since she rests her case in part on those results, they merit discussion.

Unfortunately, the study which the author refers to in support of her argument is subject to serious methodological deficiencies.[2] To test her hypothesis that exchange rate changes affect exports, she uses two kinds of models which she fits with different sets of data. The first model is tested with cross-section data. Four different variants of the model are tested, based on alternative dependent variables, with each variant applied separately to wheat, corn, and soybeans. The alternative dependent variables are change in the quantity of the commodity exported from the United States between 1971 and 1972, change in the quantity of the commodity exported from the United States between 1971 and 1973, change in the quantity of the commodity exported from the rest of the world between 1971 and 1972, and change in the quantity of the commodity exported from the rest of the world between 1971 and 1973.

The list of independent variables includes exchange rate changes; per capita income growth; population growth; consumer price index or wholesale price index, whichever was available; foreign supplies, defined as the production and stock of the commodity in the importing countries considered in the study, summed over all of them; expected export quantities of the United States, defined as an extrapolation of trend fitted to data from 1961 to 1973; expected export quantities of the rest of the world, defined as an extrapolation of trend fitted to data from 1961 to 1973; actual exported quantities of the United States (introduced when the third and fourth dependent variables were used); and actual imported quantities for the rest of the world (introduced when the first and second dependent variables were used). The independent variables are a combination of changes from year to year and absolutes.

This so-called test of whether changes in the

[1] It is worth noting that the large U.S. balance of payments deficits started in 1958, the year in which many European countries restored external convertibility.

[2] A statement Vellianitis-Fidas makes in the course of this discussion deserves singling out: "This second hypothesis implies a common but *unproven* assumption . . ." (italics added). It is a well-recognized methodological axiom that one does not prove assumptions. They are logical devices used to facilitate analysis. More generally, one does not prove anything when using the scientific method. The best one can do is to say that the data are or are not consistent with the hypothesis or theoretical expectation.

exchange rate affect exports is "ad hoccery" of the worst sort. Her model does not have the power to discriminate an exchange rate effect, and therefore her results should be taken with a grain of salt. A more sensible approach to the problem would be to specify a complete model of the demand for and supply of U.S. agricultural exports, transform it into its reduced form equivalent, and estimate the parameters of that equation. Clearly, the explanatory variables would be rather different than the author's collection. Just as a "for instance," a change in the exchange rate would be expected to influence the quantity imported in the importing country by changing the price of that import relative to the domestic price, if competing domestic supplies are available, and/or relative to close substitutes (or complements). To statistically separate the effect of the exchange rate, these other variables should be "controlled" by statistical means. Vellianitis-Fidas's model does not control for them and the inclusion of aggregate price indices is a far cry from what is needed.

Vellianitis-Fidas's second "test" of the exchange rate hypothesis uses time-series data. In this analysis, twenty countries were selected which had devalued or revalued their currencies at least once during the period 1960–69. Regressions were run on U.S. exports (by value and quantity) to these twenty countries for five commodities from 1954 and 1969: wheat, corn, cotton, tobacco, and oilseeds. Regressions were also run on imports of these same five commodities from the world to these countries. Time was used as a simple proxy for income, population, and "any other structural variables." The year of the devaluation or revaluation and each succeeding year was specified by a dummy variable value of 1 unless the change occurred in the last half of the year. It was then recorded for the next year. The dummy variable was defined as 0 prior to an exchange rate change. A separate dummy variable was included for each change in the exchange rate.

Not surprisingly, Vellianitis-Fidas finds little evidence for an exchange rate effect. The world is just a great deal more complicated than that. Even our more complicated models are at best very simple representations of a very complex reality. As a minimum, we should take advantage of what theory offers us to specify a model sufficiently complete that it would have a chance of separating one effect from another. Clearly, neither the models using cross-section or those using time-series data do this. The surprise would be if the coefficients of the exchange rate variable were in fact statistically significant, not that they are not.

I turn now to some of the other assertions that Vellianitis-Fidas makes in her comment. First, she alleges that the results she presents in her study "are consistent with the conditions inherent in the agricultural sector; that is, the general inelasticity of agricultural export supplies, particularly in the short run, prevents shifts of the export demand curve (caused by a devaluation) from resulting in very great changes in quantity."

To assert that inelasticity of export supply prevented there being any great changes in quantity is indeed puzzling. U.S. exports of grains were 40% larger on average in 1972, 1973, and 1974 than they had been in the previous three-year period. That hardly suggests a lack of elasticity in export supply. Moreover, much contemporary discussion has focused on this increase in exports, with the result that there was considerable pressure for, and the actual imposition of, export controls in each of the last two years.

The export supply elasticity can be rather large even if the short-run domestic supply elasticity is small. The export supply function is in effect an excess supply function whose elasticity is a weighted aggregate of the domestic price elasticities of supply and demand:

$$\epsilon = \eta\left(\frac{S}{E}\right) - e\left(\frac{D}{E}\right),$$

where ϵ is the export supply elasticity, e is the domestic price elasticity of demand, D is the quantity demanded domestically, E is the quantity exported, S is the quantity supplied domestically, and η is the domestic supply elasticity. It is anticipated that $e < 0 < \eta$. Moreover, $\frac{D}{E} > 0$ and $\frac{S}{E} > 0$ necessarily. Hence, the conditions under which ϵ would be inelastic are fairly restrictive.

To illustrate, in a recent study of Brazilian corn exports (Thompson and Schuh), the elasticity of export supply was slightly over 15, even though the short-run domestic supply elasticity was only 0.27 and the domestic demand elasticity was only −0.20. The reason for this, of course, is that Brazil exports a relatively small proportion of its output.

The export supply elasticity for the United States is not likely to be that large since we export an important share of some of our crops. Using data readily available in a recent study by Tweeten, a notion of the U.S. export supply elasticity can be obtained. For the 1963–65 period (prior to the recent increase in exports), average domestic use of food and feed (which is the bulk of our output) was $24.83 billion and exports were $4.28. (Cotton and tobacco are omitted.) Tweeten suggests that the domestic short-run price elasticity of demand for the food and feed component of U.S. farm output is −0.25 and that the long-run elasticity is −0.10. If we make the plausible assumptions that the elasticity of supply is 0.2 in the short run and 1.0 in the long run, then the short-run export supply elasticity is 2.86 and the long-run elasticity is 6.48. Even if one makes the extreme assumptions that the short-run elasticity of both demand and supply is 0.1 (±), the export supply elasticity is still 1.26.

Vellianitis-Fidas' next assertion is that her failure to find significant results for the exchange rate variable "could be explained by the generally accepted idea that the demand for agricultural exports is very price inelastic." There is nothing "generally accepted" about these elasticities, and a more appropriate statement would have been that there is a great deal of controversy about how large they are. This would have focused the issue with more accuracy than her sweeping *obiter dicta*.

Contrary to what Vellianitis-Fidas asserts somewhat later, theoretically the expectation would be that the impact of a devaluation or change in the exchange rate would be large. With a few important exceptions, such as coffee in Brazil and some of our grain exports, most countries are only marginal exporters of their output. Similarly, most countries are only marginal importers and use imports as a complement to domestic production (U.S. imports of coffee being an important exception again). As Harberger noted some years ago, the import demand elasticity with respect to price would likely be quite high for just this reason.

Direct estimates of import demand elasticities have usually been found to be quite low. One reason for this is that there is a rather serious identification problem in estimating the parameters of the import demand equations. This problem can be circumvented by building up the estimate from knowledge or assumptions about the respective domestic demand and supply elasticities, using weights much in the manner used with the export supply equation above.

In Tweeten's careful study of the demand for U.S. farm output, he gives us just such estimates. Under essentially a free trade assumption, he finds a maximum price elasticity of −15.85. It is worth noting that 9.50 points of this are imputed to foreign demand and 6.35 are imputed to foreign supply. The latter is important, for it is often not fully recognized that changes in the exchange rate affect both the quantity demanded and the domestic quantity supplied in the foreign country and that these adjustments reinforce each other in affecting the quantity demanded from abroad.

Tweeten recognizes that this free trade assumption is not realistic. Several countries receive a substantial quantity of our exports under U.S. Government programs and, as Vellianitis-Fidas notes, institutional factors such as the provisions of the Common Agricultural Policy of the European Economic Community prevent the full effect of price changes in the international market from manifesting themselves. To obtain a lower, what he describes as more realistic, estimate of the demand elasticity, Tweeten assumes that half of all EEC imports of U.S. farm commodities are part of a perfectly inelastic market because of variable levies, and includes in the aggregation only the supply and demand components for the "commercial" market composed of Canada, European Free Trade Area, and Venezuela, EEC (nonvariable levy), Japan, Australia, and South Africa. Under these restrictive assumptions the export demand elasticity for U.S. agricultural output is still −6.42. He suggests that several years of adjustment to prices would be required to realize this full elasticity.

Based both on empirical evidence and theory, we conclude that the devaluations potentially have a rather sizable effect on the foreign demand for imports and helped to trigger the price spiral of recent years. This does not imply that prices will stay at their recent high levels. As supply has time to expand, the relative price of agricultural products in the United States should decline to a point where they are higher than their predevaluation relatives by something less than the amount of the devaluation. If the 13% devaluation constitutes an equilibrium, the increase in the relative price of agricultural products after adjustments have worked themselves out may be something on the order of 10%. That is no small amount for a change in the internal terms of trade, however.

The obvious corollary of this analysis, of course, is that when the dollar was overvalued, it was also having a not negligible effect on agriculture. What remains to be determined with a great deal more confidence is when and how much the dollar was overvalued.

To conclude, those who argue that the devaluation had (or could have) no effect are essentially arguing that price does not matter, either on the demand or supply side. Considerable progress has been made over the last decade or so in divorcing ourselves of that notion. Clearly there are impediments to trade which prevent price changes in international markets from being passed into domestic economies in numerous countries. But equally as clearly, the world market in agricultural products is not completely bound up with trade restrictions.

To understand our historical record a great deal of additional research is still needed. It could well be that the export subsidies (which are a form of sectoral devaluation) and the price support programs acted to fully offset the effect of the overvaluation of the dollar. But clearly we do not know with our present state of knowledge. Those policies have in the past been interpreted as full subsidies by a large part of the community of professional economists. If they were in fact little more than offsets to our exchange rate and trade policies, they must be viewed in a rather different and perhaps more favorable light, since it may be that they did little more than offset the export tax implied by the overvaluation of the dollar. Even in that "best" of worlds, however, we are still left with the deleterious effects of the macroeconomic policies used to deal with the recurrent balance of

payments problems, policies which clearly had a pernicious effect on agriculture.

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Natural Resources and Agriculture under Capitalism: Marx's Economic Model

Michael Perelman

Of what relevance is the labor theory of value in modern agricultural economics? A superficial reading of commentators on Marx leads to a negative response to this question. Since labor alone produces value, resources, they maintain, are ignored, leading to a distortion of the economy (for example, see Samuelson, pp. 625, 637). A closer reading of Marx's own words, however, contradicts this reproach, revealing Marx as an extremely serious student of agriculture, who both critiques the handling of natural resource economics by his contemporaries while constructing an alternative theory which should be of interest to economists concerned with natural resource problems today.[1]

Resource Use under Capitalism

To begin, we must understand that land for Marx was like fixed capital. He wrote:

> Land as capital is fixed capital; but fixed capital gets used up just as much as circulating capital. Improvements to the land need reproduction and upkeep; they last only for a time; and this they have in common with all other improvements used to transform matter into means of production. If land as capital were eternal, some lands would present a very different appearance from what they do today, and we should see the Roman Campagna, Sicily, Palestine, in all the splendour of their former prosperity. (1973, Pp. 164–65)

Other resources, more easily depleted, are also comparable to capital. "Uncaught fish," he wrote, "are a means of production in the fishing industry" (1906, p. 181).

Of course, land is not capital as such, but it does have much in common with capital. Neither are directly productive of value and both enhance the productivity of labor (Marx 1974, pp. 71, 748). Land, as well as capital goods, once produced, fluctuates in price independent of value. Marx criticized classical political economists for treating capital as if it were of fixed efficiency (1906, p. 668). Similarly, the efficiency of land was not fixed since fertility can and is produced by human labor (Marx 1968, pp. 139–49).

The model which determines how much new fertility capitalists will invest in or how much they will maintain is complex, requiring recently developed mathematical tools such as dynamic programming. However, Marx did suggest how this model would operate in a general way. To begin with, agriculture can generate or absorb investment funds in the following fashion. Agriculturists decline to maintain the fertility of their land, freeing funds to flow to industry either by direct investment or, what is more likely, by way of expanded consumption whereby only a fraction of these funds would be investable, or rising food demand requires new investment in fertility to expand supply. Other cases are, of course, possible, but only these two need concern us here.

Declining Fertility

In the early stages of capitalism, agriculturalists neglect the fertility of their lands. The reasons Marx gives are twofold. First, landlords reap the benefits from investments in fertility by increasing rents upon expiration of the lease (1967, 3:274, 619). But the problem of maintaining the quality of resources goes deeper into the structure of capitalism. Secondly, both factory owners and farmers allow long-lived capital investments to fall into disrepair (Marx and Engels, p. 270). This reluctance to tie capital up in durable capital stems from the danger of unexpected market conditions which can wipe out the value of an investment before it has paid for itself.

Most of what has been said about land holds for natural resources in general; however, a further complication comes from the rhythms of agriculture. Factories can speed up the rate of turnover of their capital through extensions of the working day (Marx 1906, pp. 404–5), while farms are limited in their working hours as well as in the seasons of work (Marx 1968, p. 20).

To minimize the capital tied up in natural resources (or long-lived capital for that matter) profits are siphoned off as fast as possible and invested in industries with a more rapid rate of return. Forests, for instance, are cut while almost no effort is made to replant for future use (Marx 1967, 2:244, 3:617). "In the extractive industries, such as fishery and mining, labour merely casts an overpowering obstacle in the way of seizure and appropriation of the raw products or primary products" (Marx 1974, p. 715; 1971, p. 182).

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[1] Even during the last years of his life while he was hampered by ill health, Marx occupied himself by studying "agronomics, agricultural conditions in America and especially Russia" (1967, 2: 11). Upon Marx's death, Engels was amazed to discover that Marx had collected more than two cubic meters of documents containing nothing but Russian statistics (McLellan, p. 422).

To understand the meaning of this situation, we must refer to the theory of optimal resource management. For a farmer to maximize the expected present value of his operation he should maximize the sum of the net cash returns to farming, plus the value (in a planning sense) of the stock of resources carried over into the next period, where this value depends upon the shadow price of resources. The higher the shadow price is, the more the farmer would invest to maintain or even increase the fertility of the land. Because of the uncertainties of the market, the shadow price is low. Thus, while the price of land reflects its anticipated power to generate rents (Marx 1967, 3:244, 1974, p. 309), the fact that "the whole spirit of capitalist production . . . is directed toward the immediate gain of money . . . in contradiction to agriculture" (Marx 1967, 3:617) together with the reluctance to face long-term risk, and, Marx would probably add, the desire for liquidity to be able to take advantage of opportunities of "the immediate gain of money," would be reflected in a lowering of the shadow price of land.

The rational profit-maximizing farmer will deplete the fertility of the soil to the detriment of society as a whole. Modern economists are only now coming to realize this problem in their theory (Burt and Cummings). As a result of the economic incentives to deplete the fertility of the land, Marx concludes that "agriculture, which has to minister to the entire range of permanent necessities of life required by the chain of successive generations is confronted everywhere with insurmountable barriers stemming from private property" (Marx 1967, 3:617).

Among these barriers erected by capitalist production was the one separating town and country. Here Marx's critique parallels that of the contemporary environmental movement. (See Borgstrom.) According to Marx, "Capitalist production . . . disturbs the circulation of matter between man and the soil; i.e., prevents the return of the soil to its elements consumed by man in the form of food and clothing. By this action it destroys at the same time the health of the town labourer" (1906, p. 554). Marx repeats this charge in the third volume of *Capital* (1967, p. 813) and then writes to Engels that "cultivation when it progresses in a primitive way [i.e., capitalistic] and is not *consciously controlled* leaves deserts behind it. . . . Here another unconscious socialist tendency!" (Marx and Engels, p. 237.)

Marx leaves little doubt about how important he considered these barriers. After reading books on agricultural chemistry by Liebig and Schonbein, he wrote to Engels that they "are more important in this matter [of the economic role of agriculture] than all the economists put together" (Marx and Engels, p. 204).

Investment in Fertility

All production ultimately depends upon the continued flow of raw products and raw materials. In the early stages of society these materials cost little effort because "nature . . . assists . . . as a machine (Marx 1968, p. 109; see also Marx 1967, 3:360–61, 745). "But . . . in the course of development, a larger output is demanded than that which can be supplied with the help of natural power; i.e., . . . this additional output must be created without the help of this natural power, then a new additional element enters into capital. A relatively larger investment of capital is thus required in order to secure the same outputs" (Marx 1967, 3:745).

As a result, the shadow price of natural resources will rise, resulting in more investments in natural resources. Thus, we might expect the case of an increased investment in fertility to become operative. Marx does not seem to suggest any ultimate environmental demise of society, except in one instance where he writes that "*anticipation* of the future—real anticipation—occurs in the production of wealth only in relation to the worker and to the land. The future can indeed be anticipated and ruined in both cases by the premature overexertion and exhaustion, and by the disturbance of the balance between expenditure and income. In capitalist production, this happens to both the worker and the land" (1971, p. 309).

The consequences of environmental deterioration are more likely to be indirect, as the rising cost of raw materials and raw products depress the rate of profit (Perelman 1974), not so much in the manner in which it occurs in Ricardo's *Principles* as in the unpublished work of Ricardo's last days (Meek, p. 120).

On the other hand, Marx did not overlook the importance of technical change. In fact, while the classical economists and even most of their successors down to Marshall concluded that rapid technical change was impossible in agriculture (Perelman 1973), Marx predicted that technical change would occur faster in agriculture than in industry (1968, pp. 109–10). Marx's superior understanding of the farm process derived from his insight into the use of purchased inputs in agriculture.[2] With the evolution of capitalist farming, inputs once produced on the farm come to be purchased from capitalist manufacturers. This process will be sped up as these purchased inputs become cheaper and more efficient (Marx 1968, p. 112). Moreover, the expenses necessitated in agricultural improvements such as were discussed also imply an increase in the amount of capital "incorporated in the soil" (Marx 1967, 3:619; but see the warning in Marx 1968, p. 307).

Rent

An understanding of the role of rent requires a few preliminaries about Marx's model in general. According to Marx, as was mentioned before, all value comes from labor. A portion of this value

[2] Engels even corresponded with Marx about the energy consumptiveness of agriculture (Marx and Engels, p. 410).

goes to the worker, leaving the rest (the surplus value) for capital to appropriate. In advanced capitalist economies, individual capitalists do not receive surplus value in proportion to the value produced by their workers but rather in proportion to the amount of capital they employ. This division of surplus value which Marx called a "communism of capital" (Marx and Engels, Marx 1971, p. 83) tends to equalize the rate of profit from one industry to another.

When rent is considered, this model becomes a little more complex but far richer in its realism. For Marx, "rent is a product of society and not of the soil" (1973, p. 165; see also Marx 1967, 3: 815).

Since agriculture employs relatively little capital, the price of farm produce should fall below its value; that is, farmers' share of the pool of surplus value will be proportionate to the capital used in agriculture, leaving surplus value produced in agriculture in the hands of nonfarm capitalists.

The existence of landed property complicates this situation. Ownership of land is a monopoly power and rent is a monopoly payment. Marx, writing in England, where most farmers rented their land, saw that they had to accept the rent of their land as a part of their production costs (1968, p. 590).

Some students of comparative economics feel that by basing his model on the situation in England of his day, Marx made his model inapplicable for the contemporary United States. However, 40% of the U.S. farmland is rented (Johnson, pp. 1–3) and this proportion will probably increase since both young farmers and large farmers rent more land than older farmers and small farmers both of whom are more likely to cease farming. Furthermore, rent still exists conceptually even if farmer and landlord are united in a single person, since the land-owning farmer will still expect to earn a return on land.

Although land is a free gift of nature without value, landlords have the power to command a price[3] since there is no way that farmers could "compel landed property to fall to the cost price." Even in England, Marx observes, following Smith, landlords will not allow another to use their property without payment even when it cannot command a differential rent (Marx 1968, pp. 332–33).

As a result of this monopoly power, rent must be paid on all land, even the marginal unit of land; that is, rent must be paid for land as such (absolute rent), as well as for the degree of fertility (differential rent).

A second element of power besides the power of landlord over farmer partially determines the level of rent, namely, the power of the farmer over agricultural labor. Marx recognizes that the low standard of living of agricultural labor is a source of surplus value (1971, p. 188) which forms a further "*potential basis* of rent" (1968, p. 17).

Since the level of rent depends upon the monopolistic powers of landed and agricultural interests, its price is not determined by market forces. The price of food depends upon the cost of rent and not the other way around (Marx 1968, pp. 155, 161). Thus, rent is not an efficient allocator of resources as Malthus or Samuelson would have us believe.

The monopoly powers of the landlords are not eternal since the increasing utilization of purchased inputs eventually leads to a disappearance of the importance of the "labors of nature" in agriculture, wiping out the difference between industry and agriculture on the marginal unit of land as technology substitutes for natural fertility. Thus, the power of the landlord is reduced and absolute rent disappears.[4] References to this disappearance are scattered through the second part of *Theories of Surplus Value* (pp. 93–94, 105, 243). Marx does not describe the elimination of absolute rent in these terms. He writes:

> Just as it is the *monopoly* of capital that enables the capitalist to squeeze surplus-labour out of the worker, so the monopoly of land ownership enables the landed proprietor to squeeze that part of surplus-labour from the capitalist which would form a constant *excess profit*. But those who derive rent from monopoly are mistaken when they imagine that monopoly enables the landed proprietor to force the *price of the commodity above its value*. On the contrary, it makes it possible to maintain the *value of the commodity above its average* price; to sell the commodity not *above* but *at* its value. (1968, P. 94; see also p. 105)

Marx's reasoning depends upon the following line of analysis:

> But it may be asked: If landed property gives the power to sell the product above its cost price, at its value, why does it not equally well give the power to sell *above* its value, at an arbitrary monopoly price? On a small island, where there is no foreign trade in corn, food like every other product, could unquestionably be sold at a monopoly price, that is, at a price only limited by the state of demand. . . . (1968, Pp. 332–33)

In short, the monopoly of the landlords is of a very limited nature, circumscribed by foreign competition from driving prices above their value.

However, Marx himself recognized that differences in technique and fertility imply that the upper bound on the price of agricultural goods will not necessarily lie exactly at the same level as domestic value (1968, p. 19). Transportation costs will also affect this upper bound for agricultural prices.

Marx's insistence on the equality of price and value weakens his analysis of rent. A superior line of reasoning in Marx seems to be the following: Since land is not produced, its price is an "irra-

[4] Increasing size of farms might also decrease the importance of

tional expression" (1971, p. 519; see also pp. 479–80). As we have stated before, this irrationality will lead to contradictions in capitalist production. Eventually, as seen above, the production of agricultural goods will require as much constant capital per unit of labor on the marginal unit of land as is required in industry, making the "labors of nature" more or less inconsequential.

Not only does Marx expect "the conscious scientific application of agronomy" (1967, 3:617) but he also expects that "agriculture" eventually "becomes merely the application of the science of material metabolism" and that the worker inserts the process of nature, transformed into an industrial process, as means between himself and inorganic nature, mastering itself (1974, p. 705). Engels is more specific in his example of "alizarin, the colouring of the madder, which we no longer trouble to grow in the madder roots in the field, but produce much more cheaply and simply from coal tar" (Schmidt, p. 123).

Conclusion

While the labor theory of value has been criticized for its neglect of natural resources, Marx actually gave great attention to the role of natural resources. His model begins with a period of rapid depletion of resources followed by a period of investment in developing resources in which technical advances increase the efficiency of producing natural resources. However, technical change plays an ambivalent role in Marx's theory since it increases the profitability of an individual firm while depressing the rate of profit of the economy as a whole.

Rent itself, rather than acting as a rational allocator of resources, is for Marx an irrational element which distorts the price system. Thus, Marx could charge Samuelson with a faith in the optimality of the price system which is unjustified in the light of the irrational element created by rent even in a system of perfect competition.

Ultimately, Marx looks to a socialist organization of society which will be capable of rational resource use. This fact probably explains why Marx did not write more about the collapse of capitalism because of natural resource problems. Engels probably reflects Marx's own views when he looks to the day when "man's encroachments into nature will be rationalized, so that their remoter consequences will remain capable of control. In this way, nature will be robbed step by step of the possibility of revenging itself on men for their victories over it" (1940, p. 293).

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Marketable Surplus Functions for a Subsistence Crop: Rice in the Philippines

Zenaida Toquero, Bart Duff, Teresa Anden-Lacsina, and Yujiro Hayami

Despite its critical importance in the design of agricultural price policy in developing countries, the price response of marketable surplus for a subsistence crop has remained a major unsettled issue. Ample evidence is available that subsistence farmers adjust their production in response to price changes (Krishna 1967). However, few empirical estimates exist on the price response of farm households in allocating the produced output between home consumption and market sale, although there have been a number of indirect inferences (Behrman; Krishna 1962, 1965; Krishnan; Mangahas, Recto, and Ruttan; Mubyarto). Moreover, limited attempts to estimate the price response directly have yielded mutually conflicting results (Bardhan; Bardhan and Bardhan; Haessel).

Difficulty in the empirical estimation of the price response of the marketable surplus and home consumption for a given output following harvest stems simply from the unavailability of adequate data which relate marketable surplus and/or home consumption to price. In this study we attempt to fill this critical gap by estimating the price responses for both the marketable surplus and that portion retained for home consumption using sample survey results for three consecutive years.

The Simple Economics of the Marketable Surplus

By identity the output of a subsistence crop (Q) is divided into the quantity consumed by the producer's household (C) and the quantity sold in the market (M):

$$(1) \qquad Q = C + M.$$

The simple economics for allocating Q between C and M are demonstrated in figure 1a.[1] The horizontal axis (OW) measures the quantity of output of the subsistence crop (rice) with the distance from O to the right measuring the quantity offered for market sale and the distance from W to the left measuring the quantity kept for home consumption. The vertical axis measures the quantity of X, a good which represents the composite of all commodities except rice which are consumed by the rice producer's household.

Suppose the income of a rice farmer is generated solely from the production of rice. For a given output of rice (Q_0 in figure 1a) the farmer will attempt to allocate output between home consumption and sale in order to maximize the economic welfare or utility of his household members. It is assumed that utility is derived from both the consumption of rice and the composite good X. Let $P = P_r/P_x$, where P_r is the price of rice and P_x is the price index of nonrice commodities (X). If P is P_0 in an initial period, the rice farmer can move along the line P_0A_0 by trading rice for X. The equilibrium allocation of rice output between home consumption and sale would be established at E_0 where a consumption indifference curve (U_0) is tangent with P_0A_0. At this point of equilibrium, M_0 out of Q_0 is traded for X_0, and C_0 is consumed.

If the price of rice relative to the price of other consumption goods changes from P_0 to P_1 to P_2, the equilibrium point shifts from E_0 to E_1 to E_2. On the other hand, in response to the output increases from Q_0 to Q_1 to Q_2 for a given price ratio P_0, the equilibrium point moves from E_0 to E_1 to E_2 as shown in figure 1b.[2]

Thus, for a given indifference map, the equilibrium quantities of marketable surplus and home consumption are determined by P and Q. The postharvest marketable surplus supply function can be expressed as

$$(2) \qquad M = f(P,Q),$$

and the demand function for home consumption as

$$(3) \qquad C = g(P,Q) = Q - f(P,Q).$$

The partial price elasticity of supply for the marketable surplus at a given output is defined as $\alpha_P = \frac{\partial f}{\partial p}\frac{P}{M}$, whereas the total price elasticity of supply for the marketable surplus (α) including production adjustments before harvest, is expressed as

$$(4) \qquad \alpha = \alpha_P + \alpha_Q\gamma,$$

where α_Q is the elasticity of market supply with respect to output ($\alpha_Q = \frac{\partial f}{\partial p}\frac{Q}{M}$), and γ is

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[1] Along the tradition of Krishna (1962) we abstract in this paper from disposition of output other than consumption and sale, and we use the words "marketable surplus," "market supply," and "market sale" synonymously.

[2] The income of the farm households from the sources other than rice (V) has the same effect as increasing Q by (V/P_r) or the effect of shifting the OA line by (V/P_x).

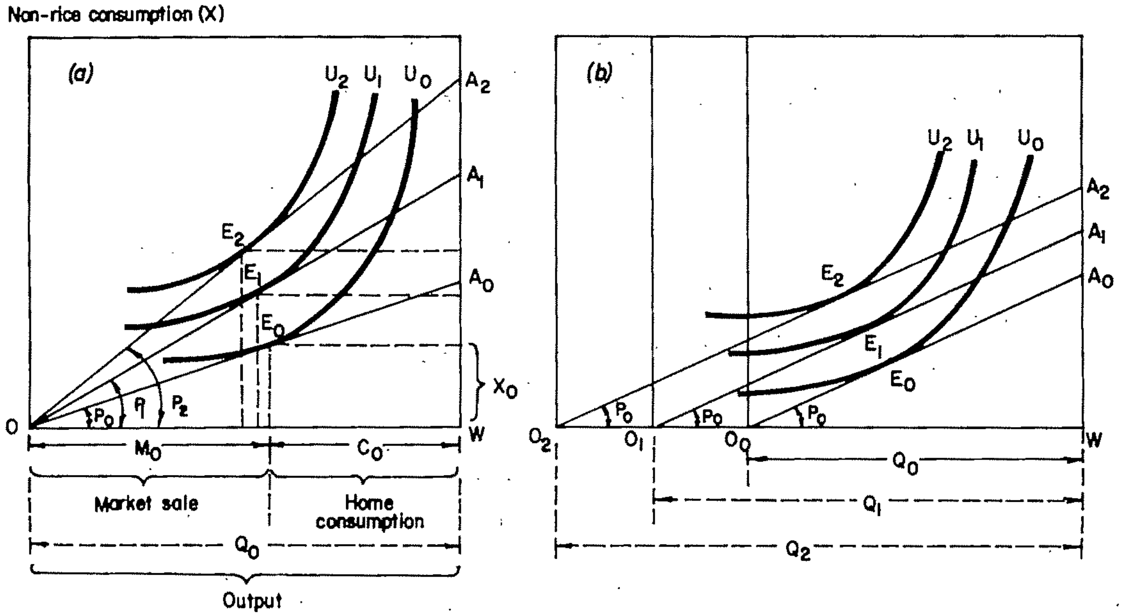

Figure 1. Model of the allocation of output of a subsistence crop (rice) between home consumption and market sale

the price elasticity of output with respect to price ($\gamma = \frac{dQ}{dP}\frac{P}{Q}$).

From equation (3) the relations between the elasticities of marketable surplus and home consumption can be derived as follows:

$$(5) \qquad \beta = \beta_P + \beta_Q\gamma = -\frac{M}{C}\alpha_P + \left(\frac{Q}{C} - \frac{M}{C}\alpha_Q\right)\gamma,$$

where β and β_P are the total and the partial price elasticities of demand for home consumption respectively, and β_Q is the elasticity of demand for home consumption with respect to output.[3]

Empirical Evidence for Rice in the Philippines

The problem of estimating the total price elasticity of marketable surplus and home consumption (α and β) for rice is to obtain empirical estimates either of the partial elasticities of market supply (α_P and α_Q) or of the partial elasticities of demand for home consumption (β_P and β_Q) in addition to the estimate of price elasticity of output (γ).

The price elasticity of output (γ) may be approximated by the elasticity of price response in the area planted for rice. Estimates of the area response elasticity for rice in the Philippines are available from a study by Mangahas, Recto, and Ruttan. Their estimates of the short-run elasticity (allowing a one-year time adjustment) and long-run elasticity (allowing indefinite time adjustment) for different regions and different model specifications are distributed with means of 0.3 and 0.5 respectively. In the present analysis, 0.3 and 0.5 are adopted as the boundary estimates for γ.

The major difficulty is in obtaining the partial elasticities of market supply or home consumption. These parameters are estimated using sample survey data showing the disposition of output by the same rice farmers for three consecutive years (1972, 1973, and 1974) in two major rice-producing regions in the Philippines (Central and Southern Luzon). Both time-series and cross-regional variations in the prices of rice and other consumption goods are included in the data. Twenty-one monoculture farms were selected for the analysis (twenty for 1974), resulting in a total of sixty-two observations.

Corresponding to equation (2), two models are specified for estimating the market supply parameters:

$$(6) \quad M_{tt} = a_0 + a_1P_{tt} + a_2Q_{tt} + a_3Q^2_{tt} + a_4N_{tt} + e_{tt}$$

and

$$(7) \quad \left(\frac{M}{N}\right)_{tt} = b_0 + b_1P_{tt} + b_2\left(\frac{Q}{N}\right)_{tt} + b_3\left(\frac{Q}{N}\right)^2_{tt} + e_{tt},$$

where Q = disposable output for the rice producer's household which is obtained by subtracting rent and production expenses in kind from total rice output, M = quantity of rice offered for market

[3] The partial elasticities with respect to output (α_Q and β_Q) can be interpreted as the "real" income elasticities assuming that the farmers are producing only rice and the inputs for rice production are more or less proportional to output.

sale, P = price of paddy received by farmers deflated by an index of prices paid by farmers for nonrice consumption goods, N = number of farm household members per farm, e = error term, and the subscripts t and i identify the crop year and farm respectively.[4]

The quadratic term for Q is introduced in the equations in order to test the hypothesis that home consumption increases less than proportionally and the marketable surplus increases more than proportionally with increases in output. This is a plausible hypothesis considering that rice is a basic subsistence requirement which has to be satisfied first in consumption. The number of household members (N) is included either as a separate variable or as a deflator of quantities to adjust the influence of family size on consumption. A price index of nonrice commodities was constructed by aggregating the prices paid by farmers for twelve nonrice commodities collected in the survey using the same weights employed in the consumer price index developed by the Central Bank of the Philippines (original data are available upon request from the authors).

Possible changes in farmers' behavior over time and space were adjusted by including 1974 and 1975 time dummies and a regional dummy (1 for regions where electricity is available and 0 for other regions).

The estimation results for equations (6) and (7) using ordinary least squares are reported in table 1. The coefficients of the dummy variables are not statistically different from zero at standard levels of significance indicating the stability of the specified relations over time and space. Subsequently, the analysis has been conducted by deleting the dummy variables. The coefficients of P are positive but not statistically different from zero. The regressions estimated by deleting the price variable (6.3, 6.4, 7.3, 7.4) indicate virtually no change in the coefficients of other variables and in the goodness-of-fit to the data measured by the coefficient of determination adjusted for degrees of freedom.

The coefficients of Q and Q^2 are positive and all have large t-ratios. The results strongly support the hypothesis that the marketable surplus increases more than proportionally with output when the home consumption demand for rice is near a point of saturation. As expected, the coefficients of N are negative, showing the proportional increase in home consumption to family size.

The findings of the regression analysis are consistent with the results of a motivation survey that we have conducted, showing farmer's disposition of rice in response to changes in output and price (table 2). Out of twenty-one farmers interviewed, nine farmers replied that they would sell all of the increased output, seven farmers intended to sell a part and retain the remainder for home consumption, and only two farmers would consume all of the increase in output. These responses indicate that an increase in output results in an increase in both home consumption and market sales. On the other hand, out of the twenty-one farmers interviewed, only one replied that he would increase home consumption if the price of rice were to increase and two farmers replied that they would

[4] Estimation of the home consumption function using the same specification produces similar results.

Table 1. Estimation Results for the Marketable Surplus Function

		Regression Coefficients							
						Time Dummies			
Regression Number	Constant Term	P	Q	Q^2	N	1973	1974	Regional Dummy	$\bar{R}^2$
6.1	−2.64	1.208 (1.37)	0.739 (10.31)	0.00031 (2.71)	−5.960 (4.21)	−10.371 (1.02)	0.752 (0.08)	0.413 (0.055)	0.957
6.2	−9.46	0.755 (1.05)	0.732 (10.45)	0.00032 (2.86)	−6.099 (4.33)			−0.172 (0.024)	0.957
6.3	−9.58	0.753 (1.06)	0.732 (10.55)	0.00032 (2.89)	−6.089 (4.57)				0.958
6.4	−14.70		0.717 (10.54)	0.00035 (3.25)	−6.191 (4.66)				0.958
		P	Q/N	$(Q/N)^2$					
7.1	−4.15	0.008 (0.08)	0.663 (8.30)	0.0041 (3.12)		0.156 (0.13)	0.799 (0.69)	−0.383 (0.43)	0.954
7.2	−4.35	0.021 (0.23)	0.668 (8.51)	0.0040 (3.10)				−0.229 (0.27)	0.955
7.3	−4.37	0.018 (0.21)	0.666 (8.59)	0.0041 (3.15)					0.956
7.4	−3.80		0.663 (8.81)	0.0041 (3.35)					0.957

Note: Figures in parentheses are t-values.

Table 2. Motivation Survey on the Disposition of Rice in Response to Changes in Output and Price, Central and Southern Luzon, December 1974

Item	Number of Farms	%
Question 1: If your rice yields would increase by 20 cavans, how would you dispose of the increased output?		
Answer:		
Sell all of it	9	43
Sell part and consume rest	7	33
Consume all of it	2	10
Others[a]	3	14
Total	21	100
Question 2: If the price of rice would increase by 10 pesos per cavan, would you change your home consumption of rice?		
Answer:		
No change	18	85
Increase home consumption	1	5
Decrease home consumption	2	10
Total	21	100

[a] Includes lending to married children and neighbors.

decrease home consumption, but by far the majority planned no change in home consumption in response to a price rise. Clearly, price has a negligible effect in the allocation of output to home consumption and market sale. These results confirm the findings of the regression analysis.

The partial and total elasticities of market supply and home consumption of rice can be derived from the regression coefficients using the relations developed in the previous section. Table 3 reports the elasticities evaluated at the means of the variables, corresponding to each regression in table 1.

The estimates of the partial price elasticity of market supply (α_P) are in the range of 0 to 0.3 while the output elasticity (α_Q) is as large as 1.4, implying that total price elasticity (α), including production adjustments, ranges from 0.4 to 0.7 in the short run and 0.7 to 1.0 in the long run. Even if we assume α_P is zero, the total price elasticity of the marketable supply is as high as 0.4 in the short run and 0.7 in the long run.

The estimate of the partial price elasticity of home consumption (β_P) is in the range of 0 to −0.4 and those of the output elasticity (β_Q) are about 0.4. These partial elasticity estimates imply that the long-run impact of price changes on home consumption as measured by the total price elasticity (β) is relatively small or can be negative.

Table 3. Estimates of the Elasticities Measured at the Variable Means Based on the Regressions Shown in Table 1

	Regression (6.3)	Regression (6.4)	Regression (7.3)	Regression (7.4)
Market supply elasticities:				
Partial elasticities				
Price (α_P)	0.26	0	0.05	0
Output (α_Q)	1.38	1.37	1.38	1.38
Total price elasticity (α)				
Short run[a]	0.67	0.41	0.46	0.41
Long run[b]	0.95	0.69	0.74	0.69
Home consumption elasticities:				
Partial elasticities				
Price (β_P)	−0.36	0	−0.07	0
Output (β_Q)	0.43	0.45	0.43	0.44
Total price elasticity (β)				
Short run[a]	−0.23	0.14	0.06	0.13
Long run[b]	−0.16	0.23	0.15	0.22

[a] Based on $\gamma = 0.3$
[b] Based on $\gamma = 0.5$

Conclusion

The results of regression analysis based on sample survey data from the Philippines indicate that the allocation of rice output between home consumption and market sale within producer's households is not sensitive to price changes. Such a finding seems reasonable considering the nature of rice as a commodity filling a basic subsistence need. Clearly, there is no evidence supporting a negative price response in the market supply for a given output as argued traditionally (Mathur and Ezekiel). An increase in output has a strong positive impact on the increase in marketable surplus. As a result, the total price elasticity in the supply of marketable surplus is clearly positive.

Such results lend direct support to the indirect inferences made by Behrman, Krishna, and others regarding the positive price effects on the supply of marketable surplus for subsistence crops. Our findings imply that the price policies frequently exercised in developing countries, such as use of marketing boards and export taxes which depress prices below market equilibrium, may have an adverse effect on the mobilization of the marketable surplus for basic food staples in the long run.

Our analysis, however, does not imply that price supports or import restrictions which raise farm prices are adequate to mobilize the marketable surplus. One of our major findings is that the marketable surplus for rice increases more than proportionally to the increase in output and that the elasticity of market supply with respect to output is very high relative to the partial and the total price elasticities. This implies that increases in output resulting from the development of new technology (such as the high yielding varieties) or improvement in basic infrastructure (such as irrigation) would have a strong positive influence on the increase in the marketable surplus for subsistence crops. Policies to mobilize the marketable surplus for economic development should reflect a clear understanding of the relative costs to the society of the alternative means of increasing output, e.g., price supports versus agricultural research and extension.

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A Recursive Model of Consumption: The Case of Taiwan's Farm Families, 1964–66

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This paper presents an empirical study of the consumption behavior of Taiwan's farm families, 1964–66, using a recursive model of consumption which links farm families' consumption behavior to their income-generating behavior. Three problems are considered. The economy of Taiwan has experienced a remarkable increase in its rate of national savings since 1960.[1] With the data available, it is possible to investigate how much the farm sector could have contributed to national savings out of its incremental income. It is usually asserted that Taiwan is overpopulated and this might have weakened its savings potential for development.[2] When certain criteria of overpopulation are used, it is possible to investigate whether the farm sector of Taiwan is overpopulated. Finally, it is usually argued in development literature that the demonstration effect on consumption is an adverse factor to savings potential of developing economies. Whether a significant demonstration effect exists in the case of Taiwan's farm families can also be studied.

The first problem is investigated by comparing the estimated marginal propensity to consume (MPC) of the farm sector with the MPC of the economy as a whole. The second problem is studied by estimating the marginal cost of living and the marginal earnings of family members. A comparison of these two estimates helps determine whether the farm families are overpopulated. Since educational attainment of the family head and off-farm contact of family members tend to increase exposure of the family to a demonstration effect, the third problem is investigated by relating family consumption to educational attainment of the family head and to a "farm income ratio." The farm income ratio is defined as the ratio of farm income to total family income and is used as a proxy of the degree of off-farm contact of family members. The estimated consumption coefficients of education and of farm income ratio may be used to judge the existence of a demonstration effect.

Data and the Model

Data used in the study are for Taiwan's bookkeeping farm families. The bookkeeping data were published in averages by the Provincial Government of Taiwan in its annual *Report of Farm Record-Keeping Families in Taiwan*. In order to conduct a cross-section study, we have obtained data of individual farm families from bookkeeping records in custody of the provincial government. The study period is 1964 to 1966. A good feature of this period is the relative stability of prices. According to *Taiwan Statistical Data Book, 1968*, general prices of farm products were about 1% lower in 1965 than in 1964, and about 2% higher in 1966 than in 1965. On the other hand, prices paid by farmers were 0.8% higher in 1965 than in 1964 and 0.3% higher in 1966 than in 1965 for productive supplies and 0.7% higher in 1965 than in 1964 and 3% higher in 1966 than in 1965 for daily necessities. Because of the relative stability of prices and because of a large variation in the composition of the bookkeeping families over the years, we have pooled the three-year observations together, treating each year-family as an individual data unit. The three-year sample contains a total of 707 year-families.[3]

The cross-section data consist of the following items: (*a*) family consumption, C, including purchased and farm-produced consumption in new Taiwan dollars (NT$), which is inclusive of almost all consumption items except housing cost; (*b*) family income in NT$, Y, including farm income and off-farm income; (*c*) farm income, including sales and imputed values of farm output minus production cost; (*d*) total assets in NT$, which can be classified into a category of "major productive assets," A_p, including values of farmland and livestock inventory, and a category of "other assets;" (*e*) number of family adults, N_a; (*f*) number of family youngsters, N_c;[4] and (*g*) education of family head in school years, E. Items (*a*) through

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[1] The rate of net national savings increased from 6.6% in 1960 to 12.1% in 1963 and 18.5% in 1966.

[2] The population density of Taiwan is 365 per square kilometer at the end of 1967, one of the highest in the world.

[3] They include 271, 252, and 184 families for 1964, 1965, and 1966, respectively. A covariance analysis indicates that the pooling of the data is permissible.

[4] Youngsters of ages under sixteen.

(*c*) are flow data for the year; items (*d*) through (*g*) are stock data at year end.[5]

The consumption function is specified[6] as

$$(1)\quad \ln C = \alpha_o + \alpha_1 \ln Y + \alpha_2 \ln N_a + \alpha_3 \ln N_c + \alpha_4 F + \alpha_5 E + U_1.$$

The assets variable is not included in the consumption function because productive assets are related to consumption mainly through their ability to generate property income. In the case of Taiwan's farm families, almost all total assets are productive in nature and family income is a combination of labor and property incomes.[7] Since total income is an explanatory variable in the consumption function, it seems inappropriate to use assets as an additional explanatory variable.

Since farm labor in Taiwan is mainly provided by family members and family income includes a large part of labor income, the number of family members is not only a consumption determinant but also an income contributor. Similarly, education is likely to be an income contributor in addition to being a consumption determinant due to a possible demonstration effect. For these reasons, a single-equation model may not adequately explain the consumption phenomenon of Taiwan's farm families. We therefore specify in addition an income-generating function as follows:

$$(2)\quad \ln Y = \beta_0 + \beta_1 \ln A_p + \beta_2 \ln N_a + \beta_3 \ln N_c + \beta_4 E + U_2.$$

Equations (1) and (2) constitute a recursive model of consumption with C and Y being endogenous variables and the others being exogenous variables. The reduced form equations are

$$(3)\quad \ln C = \gamma_o + \gamma_1 \ln A_p + \gamma_2 \ln N_a + \gamma_3 \ln N_c + \gamma_4 F + \gamma_5 E + U_3$$

and equation (2) because the reduced form for $\ln Y$ is equation (2) itself. The structural coefficients and the coefficients of equation (3) have the following relations:

$$(4)\quad \gamma_o = \alpha_o + \alpha_1 \beta_o,$$

$$(5)\quad \gamma_1 = \alpha_1 \beta_1,$$

$$(6)\quad \gamma_2 = \alpha_2 + \alpha_1 \beta_2,$$

$$(7)\quad \gamma_3 = \alpha_3 + \alpha_1 \beta_3,$$

$$(8)\quad \gamma_4 = \alpha_4,$$

and

$$(9)\quad \gamma_5 = \alpha_5 + \alpha_1 \beta_4.$$

As can be seen from equations (6), (7), and (9), the gross effect on consumption is the sum of two component effects; one may be called the "net" consumption effect and the other the "income" consumption effect. The former is the variable's effect on consumption net of its effect on income and is measured by its consumption coefficient (α). The latter is the variable's effect on consumption via its effect on income and is measured by the income elasticity of consumption (α_1) times its income coefficient (β).

Estimation

As is generally understood, consistent estimates of the model can be obtained either by ordinary least squares (OLS) or by indirect least squares (ILS). The model, however, contains N_a, N_c, and E as determinants of Y. There is in equation (1) an inherent multicollinearity between $\ln Y$ and the variables $\ln N_a$, $\ln N_c$, and E. On the other hand, equations (2) and (3) are reduced-form equations containing only exogenous explanatory variables. It seems more appropriate to first estimate β and γ coefficients by OLS and then derive the α estimates according to equations (4) through (9). Insofar as the consumption function is concerned, this is ILS estimation.[8] Using this procedure, equations (2), (3), and (1) are estimated as equations (10), (11), and (12) respectively:

$$(10)\quad \ln Y = \underset{(32.9)}{6.258} + \underset{(16.2)}{0.290} \ln A_p + \underset{(11.5)}{0.369} \ln N_a + \underset{(5.4)}{0.143} \ln N_c + \underset{(4.0)}{0.036} E, \quad R^2 = 0.53,$$

$$(11)\quad \ln C = \underset{(44.6)}{7.095} + \underset{(13.5)}{0.211} \ln A_p + \underset{(16.0)}{0.431} \ln N_a + \underset{(9.0)}{0.198} \ln N_c, \underset{(-4.7)}{- 0.003} F + \underset{(3.4)}{0.026} E, \quad R^2 = 0.57,$$

and

$$(12)\quad \ln C = \underset{(6.8)}{2.542} + \underset{(17.0)}{0.728} \ln Y + \underset{(5.4)}{0.162} \ln N_a + \underset{(5.2)}{0.095} \ln N_c \underset{(-4.7)}{- 0.003} F \underset{(-0.01)}{- 0.000} E,$$

[5] Data on net wealth are not included in the three-year sample. If net wealth is a significant factor in determining consumption, a study not including it may yield distorted results. The Provincial Government of Taiwan published the bookkeeping data for 1963 on a family-by-family basis, which included the item of net wealth. When a log-linear consumption function is fitted by ordinary least squares to the 1963 data including net wealth among other variables, the *t*-ratio of the estimated coefficient of net wealth is rather small (0.03). If this can be assumed to be also true for the 1964–66 data, the lack of net wealth data will not give rise to serious bias in our large study; 1963 data are not included in the large study because education data are not available for this year.

[6] An application of the Box-Cox Chi-square test (Rao and Miller, pp. 107–111) indicates that the log-linear form is a better fit than the simple linear form.

[7] Productive assets of the sample farms account for 72% of their total assets.

[8] The ILS estimation outlined here is somewhat different from the ILS estimation used for interdependent simultaneous-equation models. In the latter case, all exogenous variables are included as independent variables in each of the reduced-form equations. But in our model, the exogenous variable F does not appear in equation (2).

where figures in parentheses are computed t-ratios of the estimates.[9] The estimates of all the structural and reduced-form coefficients have large t-ratios except the structural consumption coefficient of education.

The ILS estimate of income elasticity of consumption (α_1) is 0.728 which implies an MPC including housing cost equal to 0.588 for an average family of the sample.[10] Considering that the average family in the sample probably has a larger income than the average farm family, the MPC of an average family for the entire farm sector should be higher than for the sample. For example, the average area of cultivated land per family for all farm families of Taiwan is 1.05 hectares in 1964–66 (*Taiwan Agricultural Statistics*) while for the bookkeeping farm families it is 1.32 hectares in the same period (*Report of Farm Record-Keeping Families in Taiwan*). When the possible income difference is adjusted, the MPC of an average family of the entire farm sector is estimated to be 0.616.[11]

National income of Taiwan increased from 1960 to 1966 by NT$40,513 million and from 1963 to 1966 by NT$24,305 million at 1964 constant prices while the rate of net national savings climbed from 6.6% in 1960 to 12.1% in 1963 and to 18.5% in 1966. The associated national MPC is equal to 0.650 over the period from 1960 to 1966 or equal to 0.624 over the period from 1963 to 1966.[12] These figures are very close to the farm sector estimate. The findings here tend to support the hypothesis that the farm sector can have as high a savings potential out of a given incremental income as the other sectors of the economy.

The estimated gross consumption effect of a family adult (γ_2) is 0.431. This is equal to the sum of the estimated "net" consumption effect (α_2) which is 0.162 and the estimated "income" consumption effect ($\alpha_1 \beta_2$) which is 0.269. The estimated gross consumption effect of an adult implies an MPC or marginal living cost, inclusive of housing cost, of NT$3,576 for an average family of the sample.[13] On the other hand, the estimated adult elasticity of production (β_2) is 0.369 which implies a marginal earnings or marginal income productivity (MIP) of adult equal to NT$3,792.[14] The MPC of youngsters is estimated at NT$1,769 with housing cost included and the MIP is NT$1,572. The youngsters' MIP is slightly lower than their MPC. The difference between MPC and MIP for both adult and youngster members is not significant.[15] If overpopulation is measured either by the criterion of zero MIP or by the criterion of excess of MPC over MIP, the findings here seem to be consistent with the hypothesis that the farm families of Taiwan are not overpopulated.

The estimated gross consumption effect of education (γ_5) is 0.026 which is equal to the "income" consumption effect of education ($\alpha_1\beta_4$) because the "net" consumption effect of education (α_5) is practically zero. The zero estimate of the "net" consumption effect is consistent with the hypothesis that no demonstration effect on consumption exists via education. The estimated gross consumption effect implies that when the education of the family head increases by one school year, its consumption increases by 2.6%. This gives an MPC of education equal to NT$796 for an average family of the sample. On the other hand, the estimate of the income coefficient of education (β_4) is 0.036. The MIP of education implied herein is NT$1,355 for an average family of the sample and is greater than the MPC of education by about 70%. Considering the size of the difference between the estimated MIP and the estimated MPC of education,[16] the evidence seems to indicate that education is not only an income contributor but also a savings contributor.[17]

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[9] The standard errors of the derived estimates of α coefficients are obtained from sample estimates of the asymptotic variances of α estimates. Since the estimates of α coefficients are functions of the estimates of β and γ coefficients, their asymptotic variances are derived from the asymptotic variances and covariances of the estimates of β and γ coefficients, using the formula of asymptotic variances of functions of random variables (Goldberger, pp. 122–25).

[10] By an average family we mean a family with mean values of the variables. The MPC is calculated as follows:

$$MPC = \hat{\alpha}_1 (APC) = \hat{\alpha}_1 \exp (\overline{\ln C} - \overline{\ln Y}),$$

where APC stands for average propensity to consume which includes an estimated housing cost. The housing cost is estimated as 5% of the average value of farm buildings reported in *Report of Farm Record-Keeping Families in Taiwan 1964, 1965, 1966.*

[11] The adjustment is achieved by using the difference in land area between the sample average family and the sector average family as a proxy of their difference in income since no information is available for a direct income comparison. The estimated MPC may seem to be unusually low for a less developed economy (see Mikesell and Zinser for other countries). This is, however, not because our estimated income elasticity (0.728) is low, which is comparable to Lee and Phillips' estimates for U.S. households. Their estimates are 0.744, 0.742, and 0.519 for urban, rural non-farm, and farm households respectively. Our low estimate of MPC originates in the low APC of Taiwan's farm families (0.808 for the sample average family and 0.846 for the sector average family).

[12] The national MPC is calculated as the ratio of incremental consumption to incremental income over the period in question.

[13] The MPC of adult members is calculated as $MPC = \hat{\gamma}_2 \exp (\overline{\ln C} - \overline{\ln N_a})$ with the estimated housing cost included in $\overline{\ln C}$. This formula is similarly used for youngster members and education with appropriate revision.

[14] The MIP of adult members is calculated as $MIP = \hat{\beta}_2 \exp (\overline{\ln Y} - \overline{\ln N_a})$. This formula is similarly used for youngster members and education with appropriate revision.

[15] A very crude test has been conducted for the difference between MIP and MPC. In the case of adult members, we have MIP − MPC = $\hat{\beta}_2 \exp (\overline{\ln Y} - \overline{\ln N_a}) - \hat{\gamma}_2 \exp (\overline{\ln C} - \overline{\ln N_a})$. By roughly treating $\exp (\overline{\ln Y} - \overline{\ln N_a})$ and $\exp (\overline{\ln C} - \overline{\ln N_a})$ as constant over samples to be denoted by K_1 and K_2, respectively, we have var $(MIP\text{-}MPC) = K_1^2 \text{ var } (\hat{\beta}_2) + K_2^2 \text{ var } (\hat{\gamma}_2) - 2K_1K_2 \text{ cov } (\hat{\beta}_2, \hat{\gamma}_2)$. When this formula is used, the t-ratios of the estimated difference between MIP and MPC are 0.88 for adult members and −0.91 for youngster members.

[16] The crude test mentioned in note 15 was similarly conducted for education. The t-ratio of the estimated difference between MIP and MPC of education is 2.20.

[17] This is consistent with Freedman's findings mainly for urban households of Taiwan: higher educated people tend to consume (and even save) more but are also able to earn more. Our finding of a zero demonstration effect via education tends to suggest that higher educated farm people consume more primarily because they earn more.

Since the farm-income ratio variable does not appear in the income-generating function, its coefficient in the consumption function is the same as in the reduced-form equation. In other words, this variable does not have an "income" consumption effect and, hence, its gross consumption effect (γ_4) is identical to its "net" consumption effect (α_4). The estimated consumption effect of farm-income ratio is -0.003. Since the estimate of the "net" consumption effect of farm-income ratio has a large t-ratio (4.7), there seems to be a significant demonstration effect via off-farm contact.

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Use of Scoring Models in Evaluating Research Programs

C. R. Shumway and R. J. McCracken

This paper reports a comprehensive examination of the total research program at the North Carolina Agricultural Experiment Station. It focuses particularly on the application of a set of numerical models for ranking recommended resource reallocations.[1] The immediate goal of this exercise has been to determine which research problem areas (RPAs), as defined in the Current Research Information System classification (USDA Science and Education Staff), should be given greater emphasis at the station in the next five years.

Organization

The key actors in the study included the experiment station administration, two department head committees concerned with research planning and program implementation, twenty interdisciplinary faculty task forces, eighteen extramural scientist panels, and twenty-three academic departments. The units of primary concern for purposes of this paper are the last three groups since they also participated in the numerical rating exercise.

The task forces (each composed of five to ten research and extension faculty and occasional representatives of state agencies) reviewed the entire research program of the station. One task force was appointed for biological sciences and technology, five for animals, six for plants, three for environmental and natural resources, and five for food-fiber-people economics. Each evaluated a portion of the program, made quantitative recommendations on changes in resource use (both money and scientists) by RPA or by commodities or resources within an RPA, recommended timing for such changes, and rated each recommendation with respect to four or five prespecified criteria (to be discussed later).

Following the task force evaluations, eighteen extramural panels (each consisting of three outside scientists and chaired by a representative of the Cooperative State Research Service) conducted parallel reviews of ongoing research programs, made their own recommendations for reallocation of resources, and rated task force recommendations with respect to the same criteria.

Up to this point evaluations were interdisciplinary in nature. The twenty-three departments then reacted in a disciplinary context to the task force recommendations and extramural panel reviews. The department heads developed a third set of five-year recommendations, projected desired five-year scientist reallocations at four alternative levels of expenditure (departmental option and 120%, 100%, and 90% of current base), and rated the task force recommendations.

To assist in ranking recommendations, numerical models of the following form were used to evaluate all RPA resource increases recommended by the task forces:

$$s_i = \sum_{j=1}^{J} a_{ij} w_j,$$

where s_i is the overall score for the recommended increase to RPA or sub-RPA i; a_{ij} is the score (scale = $1, 2, \ldots, 5$) for the increase to i evaluated according to criterion j (criteria set $j = 1, \ldots, J$ consists of subjectively defined evaluation factors by which the need for alternative research is measured); the set varies according to major research area—biological sciences, animals and plants, environment and natural resources, and food-fiber-people economics); and w_j is the weight of criterion j and is specific to a research area.

Although many alternative mathematical models could have been formulated for this purpose (Shumway), the scoring model was selected because of its basic simplicity and because it has compared favorably in accuracy and sensitivity to estimation error with more widely accepted decision models for project ranking (Moore and Baker 1969a, p. 90). Scoring models are logically used when two expectations hold: (*a*) a small number of criteria can be identified which, when properly related, will specify the desirability of a decision alternative; and (*b*) a discrete scale can be developed for each criterion with sufficient range to include all relevant alternatives and only enough intervals to discriminate between those that differ significantly. For subjective decision problems such as research evaluation, the number of significant criteria against which an effort can be independently evaluated tends to be quite limited (Dean et al.). Also, a small number of inter-

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[1] This study was initiated in 1972 by the North Carolina Agricultural Experiment Station, J. C. Williamson, Jr., Director, with the assistance of the Cooperative State Research Service.

vals on a discrete scale typically provides adequate discriminatory power for the purpose of ranking activities (Moore and Baker 1969b, p. 220).

Beginning with the list of evaluation criteria used in the *National Program of Research for Agriculture* (see Fishel, p. 294), the station administration consolidated and restructured them to improve apparent independence and relevance. These proposed criteria varied between the four major research areas. They were submitted individually to members of the Research Planning Advisory Committee, comprised of department heads, first for revision of the criteria and then for specification of importance weights. Revisions, weightings, and explanations of reasons for them were prepared by each member of the committee, summarized by the administration, and resubmitted to committee members using an interactive Delphi procedure (Dalkey and Helmer). This approach, which preserves anonymity of opinions by avoiding face-to-face confrontation, was repeated twice to permit modification of initial opinions based on convincing arguments of others. The four criteria sets with the approximate wording developed by the committee are listed in table 1 with their average weights from the final Delphi round. To permit comparison across major research areas, the criteria weights for each area were standardized by the committee to sum to 100.

Without knowledge of the weight attached to each criterion, task force recommendations for increased RPA resources were independently scored on a five-point scale by each member of the three groups—task forces, extramural review panels, and department heads. However, some participants rated most RPAs in the upper three scoring intervals while others dispersed them more evenly among all intervals. Since each person did not score all RPAs, it was possible that those RPAs scored by one participant rated higher than those scored by another only because of personal differences in using the subjective model. While there are also legitimate reasons for different average scores between participants, no objective procedures were available to make such interpersonal judgments. Therefore, to permit comparison across participants, each person's score was given equal weight by adjusting proportionally so that the average overall score for all RPA resource increases evaluated by any individual was the same.

Information Generated through Application of Models

High Priority Research Areas

Ninety RPAs were recommended for resource increases. These were placed in rank order from the adjusted scores using two standards: average score by all raters and average score minus one standard deviation of all raters.[2] The second standard caused RPAs for which there was much sampling variability, difference of opinion, and/or variability in the basic predictability of the area to be ranked lower than when ordered according to the first standard. RPAs with little difference ranked higher in the second list. Ten RPAs that ranked in the top 15% using both standards are identified in table 2.[3]

RPAs are grouped in the Current Research Information System classification under nine major research goals (USDA Science and Education Staff, pp. 4–7). The first digit of the RPA number identifies the research goal it is related to. In abbreviated form, the goals are to: (*a*) insure a stable and productive agriculture, (*b*) protect agriculture from insects and diseases, (*c*) provide an adequate supply of products at decreasing real cost, (*d*) expand demand with improved products and processes, (*e*) improve marketing efficiency, (*f*) expand export markets and assist developing countries, (*g*) protect consumer health and improve nutrition and well-being, (*h*) assist rural citizens to improve their standard of living, and (*i*) promote community improvement. Based on the average of their ranks using the previous two standards, nearly half the RPAs addressing goal (*c*) rank among the upper 20% of all RPAs needing greater research. Approximately one-quarter of the RPAs addressing goals (*b*), (*h*), and (*i*) also rank in the upper 20%. Another one-quarter of RPAs addressing each of these four goals rank in the next 20%. Hence, based on the two standards, goals (*c*), (*b*), (*h*), and (*i*) are identified as the most important goals needing additional research in North Carolina.

Degree of Consistency between Participants

As expected, there was considerable difference in scores between raters and between groups of raters. Among the groups, the rank order correlation of individual RPA scores averaged over all department heads with those averaged over extramural panel participants was highest at only 0.45. Correlation between task forces and extramural panels was comparable at 0.42 while correlation between task forces and department heads was 0.24.

In addition to the difference in scores exhibited between rater groups, there was substantial variation within a group. In fact, an analysis of variance suggested that the variability in individual RPA scores between groups was not significantly different from the variability between raters of the same group. Variability was greater among task force

[2] Although this latter standard forces the rank to partially respond to the degree of variability among participant scores, it is, of course, arbitrary. The standard deviation is computed based on the assumption of a normal distribution. For the normal distribution, approximately 83% of observations lie above the mean minus one standard deviation. If the observations are skewed to the right, more than 83% of them would lie above this point; if skewed to the left, less than 83% would. For other distributions the percentage may also be different.

[3] All ninety RPAs were divided into five priority classes based on the average of their rank using the two criteria. A list of these RPAs by class is available from the authors.

Table 1. Scoring Criteria and Weights

Research Area	Criteria	Criteria Weights
Biological sciences and technology	1. Urgency—basic information needed to aid in solution to threat or problem	20
	2. Cost relevance—expected long-term benefits in relation to costs	15
	3. Degree to which similar research is not now being conducted or not likely to be conducted elsewhere (higher scores if inadequate research results expected elsewhere)	15
	4. General importance and potential for contribution to knowledge; higher scores to be assigned for greater scientific merit and potential for contribution to faculty development and improved academic performance	50
	Total =	100
Animals and plants	1. Extent to which proposed research is consistent with station, regional, and national goals in agriculture and forestry; consider economic value of the crop or animal enterprise and its products to people of N.C.	35
	2. Cost relevance—expected benefits in relation to costs	20
	3. Extent to which similar research of adequate quality is not being conducted on this commodity elsewhere (higher score for RPAs and sub-RPAs for which adequate results are not likely to be available elsewhere) and for which there is an urgent need for research results	20
	4. Potential for contribution to knowledge	25
	Total =	100
Environment and natural resources	1. Extent to which proposed research is consistent with station, regional, and national goals in natural resource development and conservation	35
	2. Cost relevance—expected benefits in relation to costs	15
	3. Extent to which similar research of adequate quality on this resource is not being conducted elsewhere (higher scores for inadequate research elsewhere) and concerning which there is public pressure, a threat to the natural resource, or a critical need for environmental protection	15
	4. Potential for contribution to knowledge	20
	5. Extent to which the research will aid in meeting broader public service commitments of the school and university beyond traditional statutory charge of the experiment station	15
	Total =	100
Food-fiber-people economics	1. Extent to which recommended research is consistent with station, regional, and national goals of promoting and protecting public health and improving family living; potential for improving quality of life and developing rural communities in N.C.	35
	2. Cost relevance—expected benefits in relation to increased costs of research in these areas	20
	3. Extent to which similar research of adequate quality is not being conducted elsewhere (higher scores for inadequate research elsewhere) and for which there is public support for research to evaluate the impact of improved agricultural technology, a threat to public health, or a need for information to support new processing industries	20
	4. Potential for contribution to knowledge	25
	Total =	100

Table 2. Ten Highest Priority RPAs for Increased Resources at N.C. Agricultural Experiment Station

RPA Number	Title
101	Appraisal of soil resources
202	Control of diseases, parasites, and nematodes affecting forests
211	Control of diseases of livestock, poultry, and other animals
301	Genetics and breeding of forest trees
307	Improvement of biological efficiency of field crops
311	Improvement of biological efficiency in production of livestock, poultry, and other animals
401	New and improved forest products
804	Improvement of economic potential of rural people
907	Improved income opportunities in rural communities
908	Improvement of rural community institutions and services

Note: RPAs are listed in numerical order.

members and among extramural panel members than among department heads. Although opinions were diverse among these respondents, it could not be concluded from the evidence that they came from significantly different populations of opinion holders. The coefficient of variation for scores of individual RPAs was often 20%–25% or more, with no systematic relationship between degree of variation and average RPA score or between variation and RPA grouping by major research goal.

As expected, substantial variation occurred both within and between rater groups. Differences in scores may occur for several reasons, all of which are likely in this case. Semantic variability arises because both the criteria and the RPAs are very general constructs and generate different mental conceptions in different people. Attitude variability arises because the effort devoted to accurately conveying personal opinions in a numerical fashion varied between individuals. Variability in appropriateness of numerical technique arises because the method of aggregating criteria weights and scores to determine the total RPA score represents participants' overall evaluations with varying degrees of accuracy. Opinion variability arises because perceptions of anticipated relative performance of additional research in an RPA differ between individuals. While the last source of variation is what we would ideally like to isolate in this evaluation, its effect is muted by the other causes.

Correlation with Departmental Scientist Projections

It will be recalled that in addition to scoring the five-year task force recommendations, department heads also prepared departmental recommendations for scientist reallocations among RPAs at four alternative budget levels: 1972–73 base level, 90% of base, 120% of base, and departmental option. Rank correlations have been computed here to determine how closely the scores related to the magnitude of these departmental recommendations.

Correlation between average RPA scores by all raters and departmental projections of scientist numbers (absolute numbers, not increases) was comparable to the better correlations between group scores. They ranged from 0.41 to 0.43 for the various budget alternatives. The correlation of scores by each group of raters with departmental projections was considerably lower, ranging from 0.08 to 0.31. In fact, the lowest correlation was between department heads' scores and departmental projections of scientist numbers. This low correlation fails to support the expectation that a strong relationship exists between the felt importance of a research area and the number of professionals needed.

In addition, RPA score correlations with projected increases in scientist numbers were markedly lower than with projected absolute scientist numbers. Since the scores pertained to the importance of resource increases, it seemed likely a priori that if there was any correlation it would be greater with the scientist increases than with absolute levels. However, it is difficult to mentally separate work that could be accomplished over an extended period with constant resource levels from what could be done with additional resources. Consequently, the scores appear to more closely reflect the perceived importance of all research in an RPA than the incremental research.

Summary and Evaluation

A comprehensive evaluation of research resource allocation at the North Carolina Agricultural Experiment Station has involved all administration and research faculty, many extension faculty, and a number of representatives from state agencies and educational institutions. Recommendations have been developed for shifting resources, and a set of numerical scoring models have been developed and used to help articulate and process opinions concerning priorities.

An important contribution of the scoring application is the apparent documentation of a great diversity of opinions. With little agreement evident either within or between rater groups concerning the importance of additional resources in individual research areas, the outcome of such an exercise must be highly dependent on who is involved. Generalizing, the evidence of this experiment adds support to what may appear to be a truism—an administrator's perspective of priorities is likely to be very dependent on just who he listens to.

However, it must also be concluded that the usefulness of this type of numerical approach to ranking

research areas has not been proven by this exercise. Although considerable resources were devoted to the research evaluation, including the scoring model application, there are enough opportunities for sizable sampling variability that confidence in the results remains tentative. A much more careful delineation of research areas, criteria, and scorer responsibilities, a more rigorous set of definitions, and a test of alternative wording schemes would be helpful but difficult steps for improving the level of confidence placed in the final ranks.

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The Short-Run Supply of Veal

W. John Jordan

In the early 1970s, cattle herds were expanding rapidly due to favorable retail beef and grain prices. This rapid buildup tended to reduce the supply of beef in the short run and reinforce an upward trend in beef prices. During 1974, however, the higher price of feed grain coupled with an inward shift of the beef demand curve due to concurrent reductions in real spendable income created a condition of unprofitably low prices for live beef. As a result, raising calves for feedlot replacement became quite unprofitable.

This incentive to reduce the supply of beef has already manifested itself to some extent through changes in the supply of veal. Slaughtering calves for veal is one of the more effective ways of reducing the supply of beef. The impact of slaughtering potential beef-producing animals, however, has a considerable lag before its effects will be felt on the retail market. An analysis of the factors influencing the supply of veal, therefore, is not only interesting in its own right but also is of considerable importance in bringing about a longer-run equilibrium in the supply of beef. Previous studies of the supply of beef have neglected veal production as a supply regulator. The number of animals slaughtered for veal as a percentage of total beef slaughter declined from 35% in 1950 to about 7% in 1973. In 1974, it rose for the first time since 1964.

An economic rationale for the short-run supply of veal centers on three considerations: the number of dairy cows and heifers on farms, the prices of alternative uses for calves, and the cost of the variable factors of production. Since the principal source of veal is dairy calves, the number of milk cows and heifers on farms should be included in estimating the short-run supply of veal. A positive association can also be expected between the supply of veal and the ratio of the retail price of veal to that of beef.

Dairy calves, however, can also be raised for beef. When the cost of raising dairy calves for beef goes down, it becomes less economical to slaughter them for veal. Hence, the supply of veal is postulated to vary inversely with the ratio of the price of beef compared to corn.

Since dairy calves are a substitute for beef calves, one would expect that as the price of calves increases, dairy calves will be bid away from slaughter for veal by feedlot operators. Therefore, an inverse relation can be expected between the ratio of the price of beef calves to the price of live beef animals and the supply of veal.

While the supply of beef in the current year depends on the decisions made last year, the decision to supply veal is made in the current year and therefore is based on the current year's relative price structure. With this background, the linear supply function to be tested is

$$V_t = B_0 + B_1(MCH)_t + B_2(P_c/P_{bl})_t + B_3(P_{bl}/P_g)_t + B_4(P_v/P_{br})_t + u,$$

where t = year; V = veal production in millions of pounds; MCH = the number of milk cows and heifers one year and over on farms as of every January 1 expressed in millions of head (the data have been adjusted for 1970, 1971, and 1972 somewhat to make these data more comparable to earlier data which were compiled differently); ΔMCH = the change in MCH from period $t-1$ to period t; P_c/P_{bl} = the average price of beef calves divided by the average price of live beef animals per hundred weight; P_{bl}/P_g = the average price of live beef animals per hundred weight divided by the average price of corn for grain per bushel; and P_v/P_{br} = the average retail price of veal as measured by the average price of veal cutlets, divided by the average retail price of beef. (All data except the average price of veal are from the U.S. Department of Agriculture. The average price of veal is from the U.S. Department of Labor.)

Equation (1.1) in table 1 gives the results for the twenty-three-year period, 1950–72. Veal production varied in the anticipated direction with respect to each one of the independent variables. The reliability of the estimated coefficients is suspect, however, due to evidence of serial correlation. Repeated attempts to eliminate this problem (Durbin) lead to the conclusion that the equation was misspecified; that is, the effect of a significant variable omitted from the equation was being reflected in the residual terms.

In an effort to correct this problem and obtain an equation that was more sensitive to the dynamics of the dairy industry, the model was respecified by decomposing the number of dairy cows and heifers on farms at the beginning of the year into a lagged stock and net change from the preceeding year. The basis for this is that the gestation period involved in calf production suggests that the available supply of dairy calves is better represented as a function of the number of milk cows and heifers on farms in the previous year than in the current one. If dairy calves are held, it will be directly at the expense of veal production, so an inverse association between the

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Helpful comments were provided by E. Renshaw, G. Hoffman, M. Bell, and a referee; however, the author assumes responsibility for any errors.

Table 1. Estimated Equations

	Constant	ΔMCH	MCH_{t-1}	MCH_t	P_c/P_{bl}	P_{bl}/P_g	P_v/P_{br}	R^2	D-W
(1.1)	870.10	—	—	0.051	−1438.00	−25.10	550.10	0.912	0.63
	(936.60)			(0.014)	(−687.00)	(−10.26)	(251.40)		
(1.2)	1165.98	−0.092	0.061	—	−2046.10	−21.15	610.43	0.948	1.36
	(33.88)	(−0.051)	(0.010)		(−800.79)	(−10.58)	(198.19)		
(1.3)	−588.46	−0.077	0.075	—	−692.45	−23.62	507.02	0.976	2.03
	(−9.44)	(−0.041)	(0.006)		(−523.13)	(−7.64)	(169.54)		

Note: Figures in parentheses are standard errors.

change in the number of milk cows and heifers on farms and veal production is expected.

The results of the respecified model are shown in equation (1.2). All variables have the expected sign and appear as important explanatory variables. To deal with the possibility of serially correlated error terms, the Durbin method for correction of first-order serial correlation was employed. This procedure, however, failed to bring the Durbin-Watson statistic out of the zone of indeterminacy (D-W = 1.71).

The dynamics of herd adjustment may provide an a priori reason for suspecting that higher-order serial correlation may exist. The age distribution of heifers directly affects the timing of future calf births. Therefore, depending upon the shape of this distribution, the adjustment of veal production to changes in the number of heifers may be spread over more than one year. A possible correlation of error terms over two periods seems plausible.

To test for this form of higher-order serial correlation, the Durbin-Watson statistic can again be used. As Blattberg shows, the Durbin-Watson statistic is an indicator of serial correlation but not necessarily only a first-order scheme. Hence, in this instance it was assumed to indicate second-order serial correlation. To correct for this, the transformation procedure proposed by Schmidt was employed. The results of this are shown by equation (1.3). The adjustment process eliminated the effects of serial correlation, and these results reinforce earlier indications that the explanatory variables are important in explaining the variations in veal production.[1]

Estimates of the relative responsiveness of veal production to each price ratio are shown in table 2. These results indicate that on average veal supply is inelastic with respect to each ratio. The same calculations made using 1972 data, however, show all three ratios as elastic suggesting that the elasticity of supply has been increasing in recent years.

Using the coefficients estimated in equation (1.3), along with the procedure suggested by Goldberger (Johnston, p. 212) for prediction when there is a priori knowledge of serial correlation, values for veal production were estimated and then compared to the actual values for each year. The resulting coefficient of determination (0.89) indicates the accuracy of the model for prediction.[2]

Veal production in 1973 and 1974 was less than predicted by the above model. The retail price freeze in the spring of 1973 and the expectation that beef prices would continue to rise when it was lifted may have helped to keep veal production down during 1973. The dramatic increase in the price of corn in 1974 and a slump in the demand for calves for feedlot operations undoubtedly reduced the number of dairy calves being diverted towards feedlots. Dairy calves kept for herd replacement, however, showed a significant increase for the first time since the early 1960s. This increase may have prevented veal production from reaching the levels predicted by the model.

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[1] Although the significance of P_c/P_{bl} dropped somewhat, this is believed to be due to the high degree of colinearity between it and P_v/P_{br}.

Table 2. Price Elasticities of Supply

Level of Variables	$E_{P_c/P_{bl}}$	$E_{P_v/P_{br}}$	E_{P_{bl}/P_g}
Mean	0.760	0.880	0.424
1972	2.020	3.061	1.483

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[2] The R^2 for equation (1.3) in table 1 is not relevant for prediction as it refers only to the transformed variables.

Variable Selection and Statistical Significance: A Sampling Experiment

R. J. Freund and D. L. Debertin

A common procedure for model building and estimation consists of collecting data on a large number of variables and, lacking precise theoretical specification of the model, using a variable selection procedure to determine which of the various variables are to be included in a model. Model parameters are subsequently estimated using the selected variables, and the resulting estimates along with standard errors and significant tests are published as results.

The use of variable selection procedures in model building and parameter estimation has considerable justification. Much research is exploratory in nature since theory is not sufficiently strong to precisely specify all aspects of a model. In such research there is naturally a considerable amount of data manipulation or "data dredging." Furthermore, Johnston has shown that the inclusion of extraneous variables in a model does not produce biased parameter estimates, while omitting essential variables does indeed produce bias (pp. 168–69). On the other hand, since the variance of predicted values is inflated by an excess number of variables (Walls and Weeks), a variable selection procedure should be an ideal tool to produce the "best" model.

However, nothing is free, and the use of variable selection procedures raises problems. These are somewhat parallel to those of multiple comparisons in the analysis of variance. It is rather well known that the unrestricted use of the least significant difference vastly distorts the stated significance levels associated with individual least significant difference tests. In a like manner, significance levels of tests on individual coefficients as well as the overall regression are distorted, particularly when the equations have been produced by a selection procedure. Limited research, such as that by Aitkin, and Diehr and Hoflin, has been conducted on such problems. However, the results of such research are not ready for wide use and are not included in the statistical computer packages which form the basis for most statistical analyses.

Statisticians are certainly aware of the distortion of the stated significance level and many users of statistics suspect such distortion. Selvin and Stuart comment: "If we decide on the basis of the data to discard one or more variables from an explanatory equation, we cannot apply standard statistical tests to retained variables as though nothing has happened" (p. 21). Draper and Smith argue that variable selection procedures can easily be abused and should be augmented by other tools and processes (chap. 8). Apparently the average user of regression analysis is unaware of these warnings or the magnitude of this distortion. This paper uses a sampling experiment to illustrate the distortion of significance levels introduced by the use of a variable selection procedure.

A sample consists of 100 "observations" of a normally distributed dependent variable with zero mean and unit variance and twenty-five associated variables with a uniform distribution with a range from 0 to 1. All variables are uncorrelated; hence, all "significant" results will be false rejections (type I errors). A variable selection procedure was implemented by performing the backward elimination (step-down) procedure (Draper and Smith, pp. 167–69) using the 10% significance level for stopping the deletion of variables. This produces an equation with all remaining coefficients "statistically significant" at the 10% level. One hundred samples were generated and subjected to this procedure.

Table 1 gives the distribution of the number of variables remaining after the selection procedure has been completed. Obviously, since 91 samples produced equations with one or more significant coefficients, the stated 90% protection against false rejection does not apply. This, of course, is expected (see Freund) since this protection is against any one test. With the probability of a type I error of 10% for each coefficient, one expects an average of 2.5 significant coefficients per equation. However, the actual mean of 3.25 in the experiment is higher

Table 1. Distribution of Number of Significant Coefficients

No. Variables Remaining	Actual No. Equations	Expected No.
0	9	7.2
1	18	20.0
2	14	26.6
3	16	22.6
4	16	13.8
5	10	6.5
6	6	2.4
7	8	0.7
8	2	0.2
9	1	0.1
Average no.	3.25	2.50

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than that and, according to a t test, is significantly different from the expected 2.5 (t = 3.40, df = 99).

The number of statistically significant coefficients in the original twenty-five variable equations should follow the binomial distribution with a sample size twenty-five and probability of "success" equal to 0.10. The resulting expected distribution of significant coefficients is given in the last column of table 1. The distribution of significant coefficients obtained with the step-down procedure is significantly different from the expected values ($\chi^2 = 67.66, df = 9$). Thus, the probabilities of false rejections in this experiment are larger than would be expected. Similar results were obtained when samples were subjected to other selection procedures. They are not presented here since they would simply cloud the main issue.

It is evident from the results that if enough variables are initially used in a data-dredging operation, ultimately a model will be obtained in which most, if not all, of the estimated parameters are "significant." Such a result may still be quite acceptable if it is stated in terms of an exploratory analysis and if adequate caveats are provided. The actually observed t-values or standard errors of coefficients are, however, still useful as indicators of relative contributions of associated variables.

No clear solution exists to the above dilemma. It is certainly not implied that we should stop using variable selection procedures or that statisticians should stop exploring more efficient exploratory data analysis procedures. In fact, in the not too distant future, statistical researchers will probably find procedures which provide the "correct" statistical significance levels for results which are due to data dredging. Unfortunately, such procedures likely will have very low power; that is, very few results will be found to be statistically significant. Furthermore, they will probably be difficult to use, particularly when in addition to using variable selection, alternate model formulations and variable specifications are used. It would seem far better for journal reviewers to become more lenient in recommending acceptance of exploratory research clearly labelled as such and to be more suspicious of research which claims not to be of this nature.

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Improving Estimates of Economic Parameters by Use of Ridge Regression with Production Function Applications: Comment

V. Kerry Smith

There has been increasing attention given to the use of biased estimators for many economic problems. They have generally been suggested when multicollinearity impedes the researcher's ability to derive stable estimates of a model's parameters with reasonable levels of precision. The basic rationale for these techniques is that one can trade off some bias to achieve a smaller variance for the parameter estimates. Thus, in terms of the mean squared error of the estimates, the techniques which allow some bias may be superior to ordinary least squares. Ridge regression is one of the most popular of the biased estimators. Brown and Beattie (1975) have recently explored the potential gains from and limitations of it for economic models. In particular, they use the technique in a series of simple (and somewhat limited) Monte Carlo experiments (see Newhouse and Omon for more comprehensive experiments) and in the reestimation of Ruttan's Cobb-Douglas functions to measure the effect of irrigation on the output of irrigated cropland in 1956. Overall, their findings indicate that the ridge estimator appears to have promise for estimating Cobb-Douglas production functions (p. 31). However, they are careful to caution the reader that "the successful application of ridge regression actually requires considerable prior information" (p. 31).

A number of authors have suggested that the ridge estimator can be given a Bayesian interpretation (Hoerl and Kennard, Goldstein and Smith). For example, Marquardt and Snee note that "least squares implies an assumption of an unbounded uniform prior distribution on the coefficient vector. . . . The ridge estimate is equivalent to placing mild boundedness requirements on the coefficient vector" (p. 6). Lindley and Smith also derive the ridge technique as a special case of a wider class of Bayes's estimators. Thus, it is clear that there are rather specific prior restrictions implicit in the ridge estimator. The purpose of this paper is to demonstrate that the ridge estimator is a member of the Theil-Goldberger class of mixed estimator. Accordingly, it can be viewed as a natural generalization of the Wallace approach to model specification using tests for exact linear restrictions.

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Thanks are due William G. Tomek and William G. Brown for helpful comments on earlier drafts of this note.

Consider the conventional statement of the general linear model:

$$(1) \qquad y = x\alpha + u,$$

where $y = T \times 1$ vector of observations on regressand, $x = T \times K$ matrix of observations on K regressors, $\alpha = K \times 1$ parameter vector, and $u = T \times 1$ vector of errors. If we assume u is classically well behaved with covariance structure, given in equation (2), and that there exists a set of stochastic prior restrictions on α, given in (3), we have the equipment to derive the Theil-Goldberger estimator and the ridge technique from it:

$$(2) \qquad E(uu^T) = \sigma^2 I,$$

and

$$(3) \qquad R\,\alpha + \epsilon = r,$$

where R = an $L \times K$ vector of coefficients for L restrictions, $r = L \times 1$ vector of constants, and ϵ = stochastic error, assumed to have zero expectation, and given covariance structure (i.e., $E(\epsilon\epsilon^T) = \Omega$). Following Theil and Goldberger, it is possible to use the properties of u and ϵ to define a generalized least squares (GLS) estimator for the model. Rewriting equations (1) and (3), letting $r = 0$, we can define the GLS estimator of α in equation (4):

$$(4) \qquad \hat{\alpha}_{GLS} = \left[[x^T R^T] \begin{bmatrix} \sigma^2 I & 0 \\ 0 & \Omega \end{bmatrix}^{-1} \begin{bmatrix} x \\ R \end{bmatrix} \right]^{-1} [x^T R^T] \begin{bmatrix} \sigma^2 I & 0 \\ 0 & \Omega \end{bmatrix}^{-1} \begin{bmatrix} y \\ 0 \end{bmatrix}.$$

Equation (4) reduces to equation (5):

$$(5) \qquad \hat{\alpha}_{GLS} = \left[\frac{1}{\sigma^2} x^T x + R^T \Omega^{-1} R\right]^{-1} \frac{1}{\sigma^2} x^T y.$$

If we assume that all parameters are subject to stochastic exclusion restrictions (i.e., $R = I_K$) and the prior information on these restrictions is equally uncertain and unrelated ($\Omega = \theta^2 I$), then equation (5) can be further reduced to equation (6):

$$(6) \qquad \hat{\alpha}_{GLS} = [x^T x + \phi I]^{-1} x^T y,$$

where $\phi = \sigma^2/\theta^2$. Thus, the ridge estimator can also be derived as a member of the Theil-Goldberger

class and does make quite specific implicit assumptions on the character of the prior information on the model's parameters.[1] While Brown and Beattie were not, strictly speaking, correct in suggesting the mixed estimator as an alternative to ridge regression, they did anticipate both a ready derivation of the ridge estimator which clearly indicates its implicit assumptions and a generalization that may be suited to wide range of problems in economics (see Smith), that is, there is no reason to assume that the exclusion restrictions have equal uncertainty or that they are independent. Hence, it is reasonable to consider estimators based on alternative specifications of Ω as given in equation (5).

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[1] Brown has pointed out to me that this interpretation implies a difference in the GLS expression for the variance-covariance of the estimates of α and that conventionally presented for the ridge estimator. If one assumes that the null vector is not a reasonable prior assumption for r, the difference can be resolved.

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Real Property Taxes and Farm Real Estate Values: Incidence and Implications: Comment

Robert J. Bevins

Deaton and Mundy in their comment on Pasour suggest the effects of the Tennessee reduction of assessment ratio for farmland may be dissipated in considerable measure by the resultant increase in market value brought on by the initial tax decrease.

Empirical studies might show that the gains are overcapitalized, but economic theory would suggest this an unlikely result. Thus, the most that economic theory might lead us to expect as rational would be immediate capitalization of the expected tax reduction so that in fact no reduction in taxes actually would take place.

This situation would be described by

$$(1) \qquad A_1V_1t = A_2V_1t + A_2t\left[\frac{(A_1 - A_2)\,V_1t}{C}\right],$$

where t = tax rate, V_1 = market value before tax system change, A_1 = initial assessment ratio, A_2 = subsequent assessment ratio, and C = capitalization rate.

If equation (1) is solved for C, we get the capitalization rate at which the expected tax reductions would just be washed out:

$$(2) \qquad C = t\,A_2.$$

It also follows that when $C > t\,A_2$ there is a tax reduction, and if $C < t\,A_2$ there is a tax increase.

Farm Real Estate Taxes estimates that in 1973 Tennessee farm real estate taxes averaged 50¢/$100 full value. To be conservative, assume a doubling of the tax rate since 1973. That would put the rate at $1.00/$100 or $t = 0.01$. In the Tennessee case, $A_2 = 0.25$. Using these values in equation (2) gives

$$(3) \qquad C = (0.01)\,(0.25) = 0.0025.$$

That in fact $C > 0.0025$ seems likely. Thus a tax reduction seems likely.

Another way of viewing things would be to compare values before and after the change in assessment ratios and to determine the market values at which the expected tax reduction would be wiped out.

This situation would be described by

$$(4) \qquad A_1V_1t = A_2V_2t,$$

where t, V_1, A_1, A_2 are indicated above and V_2 = market value after tax system change. Solving for V_2,

$$(5) \qquad V_2 = \frac{A_1}{A_2}\,V_1.$$

If $V_2 > \frac{A_1}{A_2}V_1$, the tax increases and if $V_2 < \frac{A_1}{A_2}V_1$, the tax decreases.

In the Tennessee situation, $A_1 = 0.40$ and $A_2 = 0.25$:

$$(6) \qquad V_2 = \frac{A_1}{A_2}\,V_1 = \frac{0.40}{0.25}\,V_1 = 1.6V_1.$$

This indicates the changed tax system would have required a 60% increase in market values in order to have washed out all the expected tax reduction. Such a short-run increase in market values seems unlikely.

Like Deaton and Mundy, I would expect a tendency for the tax break to Tennessee farmland owners to disappear over time as the decreased taxes are bid back into increased land values, but a look at V_2 as a function of V_1 and a look at C as a function of A_2 leads me to suspect that the washout of the tax reduction is likely to be a process of several years duration.

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The Von Thuenen Paradigm, the Industrial-Urban Hypothesis, and the Spatial Structure of Agriculture: Comment

David C. Garlow

In a recent issue of this *Journal*, Katzman provides a restatement and comparison of some variants of Von Thuenen theories and the Schultz urban-industrial hypothesis. One of his main conclusions appears to be that the industrial-urban hypothesis does not stand up in Goiás, Brazil, but that a modified Von Thuenen model, with a fixed-proportions production function for all agriculture, does explain the price gradients he derives (p. 694). A careful examination of Katzman's table 7 reveals that agricultural output per man is not significantly related to distance from Goiania. If there were product price gradients in 1940 (something Katzman does not show) and a fixed-proportions production function, then we should find a significant negative coefficient for distance in the regression of agricultural output per man on distance, not just for animal output per man on distance.

To provide a quick check on Katzman's hypothesis of a fixed-proportions production function for all agriculture, I have run his model using data from the 1970 agricultural and industrial censuses, which have recently become available. To facilitate comparison with his work, I employ the same definitions of fertility (a dummy value of "1" for all municipios or counties in the forest zone, of "0" for all others) and urbanism (county industrial payroll per capita); my "distance" variable is differently specified, however.[1] Moreover, I do not aggregate the 221 counties of 1970 to conform to the 1940 boundaries, and this may affect the regressions.

Table 1 displays my results for the 177 counties for which it was possible to calculate the urbanization coefficient.[2] Distance from Goiania is inversely related to all the value per man and value per hectare measures, as Katzman found using the 1940 data. Crop output per man and crop, livestock, and total output per hectare are all positively related to the urbanization variable. Fertility also shows a positive relationship to the value-input ratios. However, farmland per man shows a significant inverse relation to distance, in contrast to Katzman's finding of no relationship (p. 693).[3] This contradicts the hypothesis of a fixed-proportions production function for agriculture, as it indicates that the proportions of land and labor do vary.[4]

Many changes have taken place in Goiás since 1940. While the state is still a relatively unsettled area, the construction and population of the new federal capital, Brasilia, within state boundaries and the completion of a new highway all the way from Brasilia to the city of Belem on the Amazon River in 1960 may affect my test of Katzman's model with 1970 data to the extent that they led to the creation of other marketing centers.[5] However, data of the Fundacao IBGE for 1970 indicate that almost 66% of total shipments from Goiás to other states, by value, went to Minas Gerais and Sao Paulo (and hence would pass through Goiania-

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[1] Katzman measures distance along roads, while I measure them along straight lines. His measure is better but could be improved by taking into account differences in highway quality. In general, the specification of all three variables could be improved.

[2] To preserve the confidentiality of census returns, payroll figures were not published for forty-four counties which had so few firms that the county total would have revealed individual payrolls. This may affect the results.

[3] The sign of this relation is the opposite of the one Katzman (p. 693) and I would expect. However, suppose there were a distance gradient for money wages of the same form Katzman postulates for output, i.e., $w_k = w_0 e^{-sk}$, where s is a constant greater than 0. If s is greater than the price gradient for land, then as distance from Goiania increases, land becomes expensive relative to labor, leading to more labor-intensive production. To get an estimate of the value of s, I substitute my postulated wage gradient in Katzman's equations and find that now the partial derivative of $(Q/N)^*$ with respect to distance should equal $g - s$. From my table 1, average $g - s$ lies between -0.0107 and -0.0163. Katzman gives two estimates of g, both equal to 0.002 (p. 691). This means s should lie between 0.0127 and 0.0183. Since these values are greater than the highest estimate (0.011) Katzman gives for the price gradient for land, I cannot reject the hypothesis that the existence of a wage gradient may provide an explanation for this curious sign.

[4] Another test of this hypothesis would be to estimate production functions for agriculture in Goiás.

[5] Brasilia was inaugurated in 1960. In 1970 the Federal District in which it is situated had a population in excess of 500,000 (IBGE 1973, p. 47).

The highway was only raised to all-weather status in 1964 and was paved after 1970 (Valverde and Dias, pp. 333–35).

Actually the proximity of Brasilia to Anapolis and Goiania may reinforce rather than weaken the model. Now instead of two marketing centers close together, there are three! (This point was suggested by Aaron Dehter). If Belem has become important, however, some of the northernmost municipios should probably be eliminated from the area hypothesized to market in Goiania-Anapolis.

Table 1. Agricultural Factor and Output Relations, Goiás, 1970

Dependent Variable	Distance	Fertility	Urbanism	$\bar{R}^2$
Crop output/ha	−0.0068	1.4116	0.0002	0.413
	(0.0025)	(0.1662)	(0.00006)	
Livestock output/ha	−0.0123	0.8879	0.0001	0.447
	(0.0020)	(0.1323)	(0.00005)	
Total output/ha	−0.0095	1.1528	0.0002	0.473
	(0.0020)	(0.1352)	(0.00005)	
Crop output/man	−0.0107	0.3233	9.5670	0.353
	(0.0015)	(0.1035)	(3.8339)	
Livestock output/man	−0.0163	0.2003	0.000004	0.307
	(0.0019)	(0.1253)	(0.000046)	
Total output/man	−0.0134	0.0645	0.000052	0.399
	(0.0014)	(0.0949)	(0.000035)	
Ha/man	−0.0039	−1.0882	−0.0001	0.325
	(0.0018)	(0.1204)	(0.00004)	

Note: Form of the regression is $\ln Y = a + \Sigma b_i X_i$. Values in parentheses are standard deviations. The simple correlation coefficient between urbanization and distance is −0.20. Data on output and hectares come from tables 62 and 83 in IBGE 1974, on urbanism from table 2 in IBGE 1974, and on distance from IBGE 1969. The forest zone comprises all the municipios of the "Mato Grosso de Goiás" (IBGE 1974, pp. 37–41).

Anapolis), only about 12% to Brasilia and less than 3% to the state of Para (of which Belem is the capital), so the original model could still be valid (IBGE 1973, p. 375).

To sum up, the data presented here cast doubt on Katzman's hypothesis of a fixed-proportions production function for all agriculture in Goiás. His finding of an inverse relationship between distance from Goiania and the ratio of output per unit of land and of labor is reaffirmed. Degree of urbanization also exhibits significant coefficients, however. Perhaps this indicates that the state has reached a stage in which the main thrust of causation is changing; i.e., instead of prosperous agriculture giving rise to thriving cities along a frontier, prosperous cities are inducing agricultural development in surrounding areas.

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The Von Thuenen Paradigm, the Industrial-Urban Hypothesis, and the Spatial Structure of Agriculture: Reply

Martin T. Katzman

It is gratifying that my modest article on the spatial structure of agriculture has already stimulated further research, and doubly so that this research focuses upon my favorite frontier—the Brazilian state of Goiás. Using data unavailable at the time of my writing, Garlow has produced some evidence that agriculture in Goiás has become more "neo-classical" during the period 1940–70 and that industrial urbanization is beginning to exert a significant impact upon agricultural structure. These are welcome results. As the first half of my article suggests, I have no theoretical stake in a fixed-proportions production function, which was merely proposed as an ad hoc explanation.

Garlow's new evidence permits us to push the original analysis a bit further. By incorporating spatial variations in wages into the original equations (16)–(19) (Katzman 1974), one can now estimate the interest rate gradient on the basis of the following empirical relationships for the year 1970:

$$(1)\quad \frac{d(Q/N)^*}{dk} = -0.107$$
$$= g - s, = \text{rice output per man},$$

$$(2)\quad \frac{d(T/N)^*}{dk} = -0.004$$
$$= \frac{-(a+b)s}{a} + \frac{cj}{a} + \frac{g}{a} = \text{hectares per man},$$

$$(3)\quad \frac{d(V)^*}{dk} = -0.006$$
$$= \frac{-g + bs - cj}{a} - j = \text{cropland value},$$

and

$$(4)\quad \frac{d(Q/T)^*}{dk} = -0.007$$
$$= \frac{bs - cj - (b+c)g}{a} = \text{rice yields},$$

where a = output elasticity of land in rice = 0.7, b = output elasticity of labor in rice = 0.1, c = output elasticity of capital in rice = 0.1 (Cline, pp. 64–71), g = gradient of rice prices = 0.002 (Katzman 1974, p. 691), s = gradient of wages = 0.013 and j = gradient of interest rate = to be solved. Equations (2)–(4) all provide similar estimates of j, roughly 0.04–0.05. This remarkable internal consistency of the system of equations suggests the basic soundness of the Von Thuenen-type analysis of Goiás agriculture.

The observed decline in 1970 of output per man and per hectare with distance from the market is also predictable by the industrial-urban hypothesis. What is astounding is the observed decrease of hectares per man with distance from the market. While the industrial-urban hypothesis would explain this tendency by the absorption of surplus labor in the market center, the Von Thuenen model would have to posit a decline of wages more rapid than the decline of rents with distance from the market.

On intuitive grounds, neither Garlow nor myself would have predicted such a pattern of wages or land-man ratios. Why wages should decline more rapidly than prices with distance from the market (0.013 versus 0.002) is indeed puzzling for a region undergoing frontier settlement. Theoretically, the ratio of the wage gradient to the agricultural price gradient should equal the share of farm family budgets devoted to food, which in the Goiás case is approximately one-half. In a frontier region, wages might even rise with distance from the market in order to overcome the friction of migration costs. A possible explanation lies in the changing sources of migration since 1960. Prior to that time, a majority of the migrant stock came from the prosperous states of São Paulo and the moderate income state of Minas Gerais (IGBE, table 11). While prior to 1960, most interregional transportation improvements in Goiás were oriented toward these southeastern states, major trunk lines leading to the impoverished northeast were implanted and upgraded thereafter. By 1970, about half the migrant stock in Goiás originated in the northeast (da Mata). Perhaps immigration from the north has forced wages down in proportion to proximity to the northeast. It would be useful to test this explanation directly using evidence on wages for a sample of municipios in Goiás.

An interesting point is raised in note one regarding the proper measure of distance in tests of the industrial-urban and Von Thuenen models. Is airline distance or road distance the proper measure? In my article (1974), distance is measured by road, uncorrected for quality. Originally, we attempted to distinguish among various road surfaces but

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found that the better roads were invariably closer to Goiania-Anapolis, the market center. This is reasonable if roads are constructed for intraregional, farm-to-market shipments on the basis of traffic load. Closer to market, traffic densities are higher because of higher rural densities and because all traffic from outer municipios must pass the inner ones on the way to market. In other words, road quality is generally endogenous to agricultural development in the long run so long as the road-building authorities are moderately sensitive to traffic demand as an indicator of what type of road should be built and where. So long as topography is homogeneous, airline distance may be an adequate indicator of the friction of space.

Finally, Garlow's speculations on the impact of Belem in note eight have been empirically verified. In a subsequently published article (in press), I relate the structure of agriculture in northern Goiás to distance from Belem, holding distance from Goiania constant. In the years 1940–60, prior to the completion of the Belem-Brasilia highway, distance from Belem had little impact on the structure of agriculture. By 1970, rural population densities decreased with distance from Belem. This result suggests that rural Goiás is becoming integrated into both northern and southern industrial-urban "matrices."

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Efficiency and Equity in Public Research: Rice Breeding in Japan's Economic Development: Comment

P. G. Allen

The paper by Akino and Hayami is the latest to show high rates of social returns to research. (For earlier studies see Griliches, Peterson, Schmitz and Seckler, Ayer and Schuh.) Two possible reasons for estimating these historical returns are to compare returns to research with other forms of public or private expenditure and to compare returns to a particular line of research with other types of research.

The high internal rates of return typically found may be construed as returns to investments made today, which should result in rational (public) decision makers allocating more of their budget to research or to the particular line of research. I wish to show that problems exist in measuring k, the rate of proportional shift in the production function which can be attributed to each source and that the historical internal rate of return as generally calculated is misleading and not the average return usually conceived. Finally, following Mishan, I will calculate a rate of return which, though respectably large, is not as high as the conventional internal rate of return, is intuitively more appealing than the so-called external rate of return, and is a probable upper bound on the returns to be expected.[1]

Although yield increase is probably the most straightforward kind of technical change to study, considerable difficulties are still encountered, as illustrated by the following hypothetical situation. One definition of k_t, the proportional shift in aggregate production function in year t, is given by

$$k_t = \sum_{i=0}^{n}[1 - (Y_{0t}/Y_{it})]P_{it},$$

where Y_{0t} is the yield of the unimproved variety in year t, Y_{it} is the yield of variety i grown in year t, and P_{it} is the proportion of total acreage in variety i in year t. The series k_t, $t = 0, 1, 2, \ldots$, forms an arithmetic (Paasche) productivity index. Alternatively, $k = k_t - k_{t-1}$, $t = 1, 2, \ldots$, forms a series which gives the change in productivity, and k may be averaged over periods of years.

If we assume that yield depends on variety and one other input, fertilizer, all other factors of production held constant over all time, we are considering two response functions as shown in figure 1. Quantities q^*_0 and q^*_1 are optimum applications of fertilizer, given constant ratios over time of real price of output to input, which would give yields Y^*_0 and Y^*_1. In practice, even in the absence of technical change, the price ratio is not constant over time nor do producers know its value at equilibrium. Because of ignorance, capital limitation, risk aversion, etc., farmers are actually applying q_0 at the time the improved variety is introduced, while if experiment station trials are carried out with input level near q^*_0, the result is an overstatement of the shift in the production function for the prevailing fertilization level, q_0. Since the level of all other cultural practices is almost certainly above average on an experiment station, the same argument applies to them.

The shift in yield from Y_0 to Y^*_0 can occur, and in figure 1 does occur, solely as a result of increased fertilization. In the known hypothetical situation, this shift implies $k_t = 0$. The value of k_t is initially calculated on the basis of a yield increase Y^*_0 to Y'_1. Now without any new variety being introduced or any change in acreage, moving from cultural level q^*_0 through q_1 to q^*_1 will cause k_t to increase and k to be positive. If improved experiment station practices are combined with a declining P_{it}, k_t could still increase over time and k be positive (which appears to be happening in table 1 of Akino & Hayami). However, if P_{it} falls to 0, k_t must also be 0, and at some point k becomes negative. Furthermore, as argued above, k_t is unlikely to be biased downwards, as Akino and Hayami claim in note 4.

The definition of k_t recognizes that new varieties discovered through research which are not adopted by farmers are valueless because $P_{it} = 0$. This implies that costs of replication, farmer education, and dissemination are to be included in the cost stream. Equally important, this whole approach is an adaptation of static equilibrium to the dynamics inherent in technical change. While we may grant that producers would eventually reach an equilib-

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This comment has benefited from helpful suggestions by Jon Conrad and the editor.

[1] The external rate of return, given by the formula

$$r_e = 100\,\frac{(iP + F)}{C},$$

is closely related to the familiar benefit-cost ratio. For an infinite annual net returns stream F, the present value t years after project initiation is F/i, where i is the market interest rate; P is the compounded value of the benefit stream at t, and C the compounded cost stream t. Thus, the benefit-cost ratio B is

$$B = \frac{P + F/i}{C} = \frac{(iP + F)}{iC}.$$

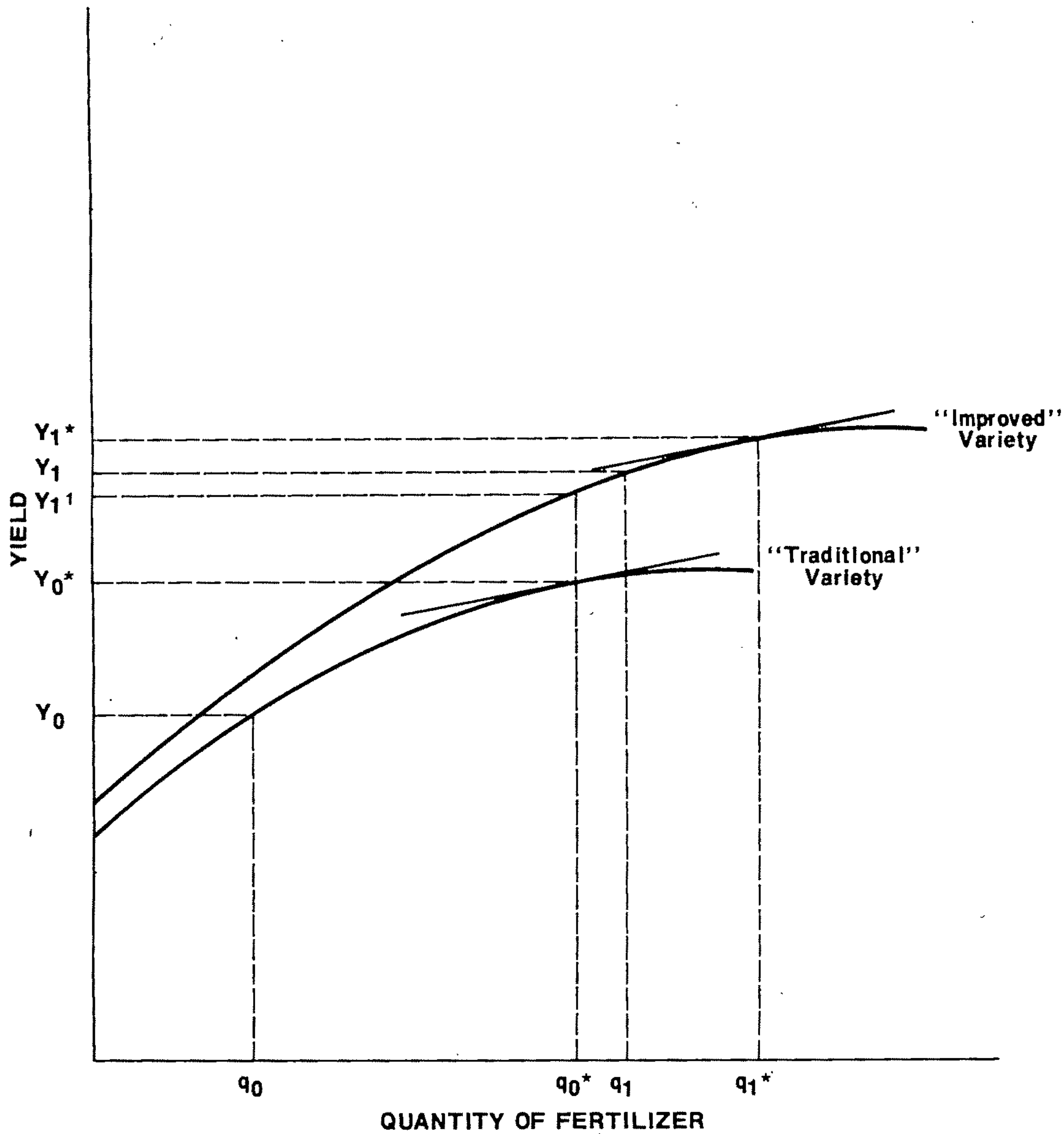

Figure 1. Hypothetical input response curves for "traditional" and "improved" varieties

rium situation if static conditions prevail long enough, it seems unreasonable to accept that the path towards that equilibrium is followed without cost. Finding the optimum level of fertilization (which in the simple example is the only optimization problem) is a research or experience problem which has costs.[3] These costs could well have occurred after the cutoff dates for breeding research of 1926 and 1950.

I turn now to the question of using the internal rate of return as a summary of benefits and costs. As noted previously, the external rate of return is a variant of the benefit-cost ratio and, as is well known, equivalency between the two returns can be shown by choosing a discount rate which will return a net present value of 0. When an internal rate of return is calculated, passing reference is generally made to two problems. In cases of multiple sign reversal in the net benefit stream, multiple (positive) rates of return exist, and reinvestment of benefits is assumed to accrue at the same internal rate.

Compounding or discounting at any positive interest rate puts more weight on the early returns, but to an extent not usually appreciated. Table 1 illustrates with artificial but realistic data that it is the length of lag and value of returns in the early

[3] I use "experience" and avoid the term "learning-by-doing" which though it can perhaps be applied to user experimentation has a history and connotations all its own.

Table 1. Internal Rates of Return to a Single Investment of $1.00

Returns Stream Length (years)	Lag Interval (years) 1	2	4	8	12
1	300.00	100.00	41.42	18.92	12.25
2	382.84	138.30	59.70	27.83	18.13
3	396.74	149.84	67.24	32.18	21.18
5	399.87	155.26	72.65	36.19	24.27
7	400.00	156.02	74.16	37.84	25.73
9	400.00	156.13	74.62	38.58	26.50
13	400.00	156.15	74.82	39.12	27.17
17	400.00	156.16	74.84	39.25	27.41
23	400.00	156.16	74.84	39.29	27.51
31	400.00	156.16	74.84	39.30	27.54
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
∞	400.00	156.16	74.84	39.30	27.54

Note: Given a returns stream of $4.00 per year of the specified length commencing after the stated lag interval.

years which are most important in determining the internal rate. First, the bottom line of the table shows the speed with which the internal rate of return to an investment with a perpetual benefit stream declines as the lag between cost and initial return increases. Second, the internal rate rapidly approaches its maximum as the length of the benefit stream increases from its shortest value.

Mishan noted an additional difficulty. Only in the particular case of but a single capital outlay (or repeated outlays with identical benefit streams per dollar invested) does the definition of the internal rate of return realize its conception as an average growth of an investment. In the usual case, where each investment has a unique benefit stream, the situation which prevailed in the early years dominates. Later investments and returns make an infinitesimal difference to the internal rate of return, implying that use of this criterion largely overlooks later research, extension, and dissemination expenditures which are required to support the introduction and use of new varieties.

Nor does use of the internal rate of return remove the decision on which interest rate is appropriate; it merely accepts that rate which in the particular situation, happens to give a zero net present value. Mishan favors compounding benefits to a terminal value: for cashable benefits at the opportunity cost of capital and for nonmarketable benefits at the social rate of time preference. In practice the market rate of interest for comparable investments is used. Additionally, the termination dates of projects must be the same or, more specifically, the evaluation point must be the same number of years after the initial investment period. Also, the present value of investments must be the same or projects must be capable of being scaled so they could be made the same size. Meeting these requirements ensures a unique normalized internal rate of return which ranks projects in the same order as the net present value over cost criterion.[3]

The results of reworking the first two columns of

[3] Normalization of the internal rate of return is achieved by taking the compounded value of benefits B', and of research expenditures C, and discounting at the same interest rate to find the present value of the latter C' in the first investment period:

$$C' = \frac{C}{(1+i)^t}.$$

The normalized internal rate of return r_n is found by solving

$$B' - C'(1 + r_n)^t = 0.$$

Table 2. Estimates of Social Rates of Return to Rice Breeding Research in Japan (Million Yen in 1934–36 Constant Prices)

	I. Before Assigned Experiment System			II. Under Assigned Experiment System		
	Year	Case A	Case B	Year	Case A	Case B
Returns cumulated to	1935	985.88	—	1951	487.98	—
Annual returns from	1936	44.63	—	1952	31.73	—
Returns cumulated to	1953	7516.50	7660.95	1961	—	1639.77
Returns cumulated to	—	—	—	1975	7330.37	6227.02
Net present value of future returns in	1953	446.30	0	1975	317.30	—
Total cumulated returns in	1953	7962.80	7660.95	1975	7647.67	6227.02
Research expenditures cumulated to	1935	140.91[a]	—	1951	18.04[a]	—
Research expenditures cumulated to	1953	783.47	783.47	1961	—	46.78
Research expenditures cumulated to	—	—	—	1975	177.65	177.65
Research expenditures discounted to	1904	7.34	7.34	1926	1.66	1.66
External rate of return measured in	1953	107.33%	97.78%	1975	448.36%	350.53%
Internal rate of return base year	1904	27%	25%	1926	75%	73%
Normalized internal rate of return, base termination date	1904 1953	15.32%	15.24%	1926 1975	18.78%	18.28%

Note: The estimates are for the autarky case of Akino and Hayami. All compounding and discounting uses an interest rate of 10%.
[a] Indicates a value calculated by compounding the base year present value. It is not the number shown in table 3 of Akino and Hayami.

table 3 in Akino and Hayami are shown in table 2. In order to use the same values as Akino and Hayami, their interest rate of 10% is assumed to reflect the reinvestment opportunities for the returns. Other rates might be considered more appropriate; this is for the researcher to decide. I made assumptions about the dates to which Akino and Hayami compounded their costs and returns, as shown in the table. Finally, in order to compare the situation before and after the Assigned Experiment System, the evaluation periods were set at forty-nine years after the initial investment. The normalized internal rates of return are much lower than those before normalization. It must be remembered that they are internal rates dependent on an interest rate of 10% in the rest of the economy. If a different rate for investment opportunities had been assumed, the normalized rate would have been different also.

One serious criticism of the normalization technique should be noted. As the length of time between the initial investment and evaluation period increases, the value of the normalized internal rate of return approaches that market rate selected for compounding. (But, until the net benefit stream falls to 0, the external rate of return also depends on the period of evaluation.) Strictly, with an infinite returns stream, the method breaks down since the returns cannot be compounded forward to a terminal value. However, by using the present value of a constant net returns stream extending to infinity, a present value of returns can be established at any point in time and a normalized internal rate of return calculated on that basis. If the other normalization requirements are met, the interest rate would be unique, would rank order projects correctly, and could directly replace the external rate of returns concept.

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Efficiency and Equity in Public Research: Rice Breeding in Japan's Economic Development: Reply

Masakatsu Akino and Yujiro Hayami

Allen's comments consist of two points. First, our estimates of the supply shift factor, k_t, is subject to an upward bias due to the use of experimental data that result in an overestimation of the rate of return to investment in rice breeding. Second, since the internal rate of return as conventionally defined is misleading, Mishan's normalization procedure should be used instead. Our response to these two comments is as follows.

Estimation of the Shift Parameter

Our estimates of the supply shifts are based on the results of the comparative yield tests conducted at various prefectual experiment stations during the 1920s and 1930s. In such experiments the applications of fertilizer were normally set at prefectual standard levels rather than at output-maximizing levels—the levels that were commonly practiced by farmers in respective prefectures. The value of k_t under consideration should be calculated not from the average yields of all farmers, but from the yields of farmers who have adopted new varieties in year t. Although the experimental results might differ from what would occur under the average farming conditions, especially in earlier years, the farming conditions of early adopters or innovators were normally above average, which would reduce the alleged upward bias due to the difference in input levels and cultural practices between experiment fields and farmers' fields.

Further, it should be pointed out that our k_t's only reflect yield differences between the improved and the unimproved varieties. In fact, contributions of varietal improvement include not only the increase in yield but also the improvements in other characteristics such as palatability and planting time. For example, Norin No. 1 selected in 1931 at the headquarter of Hokuriku (North Central Region), located at the Niigata Prefectual Station, proved to be superior in early maturity (a required characteristic in northern regions) and palatability, as compared with the major check variety, Gin-bozu. The market price of Norin No. 1 was higher by 15%–20% than the price of Gin-bozu in the 1930s, and its early maturation contributed to the increase in double cropping. Because of those superior characteristics, Norin No. 1 diffused rapidly, especially after 1935, and was planted in approximately 160 thousand hectares in 1939. Since our k's do not reflect such improvements, they may, in fact, be underestimating the contribution of rice breeding research rather than overestimating it.

Normalized Internal Rate of Return

It is well known that the rankings of alternative investment streams may differ for different criteria. The external and internal rates of return were calculated in our study in order to check if different conclusions might be derived from different criteria. As Bailey has pointed out, "The general solution of investment decision problems cannot rely solely on either the present value or internal rate of return reasoning" (p. 477).

Mishan (1967, 1971) proposed the normalization procedure to ensure a unique ranking of the alternative investment streams irrespectively of the investment criteria and the rate of discount used. The essence of his approach is that public projects should be compared at a common terminal, through treating proceeds as reinvested at the private rate of return. However, the ranking by the normalization procedure is not independent of the time period over which benefits are compounded, though it is unique for any given common period (Mabro, p. 670). Ranking reversals are likely to occur for alternative common periods. What is the rule for determining the common investment period? Mishan claims that "the common terminal date is to be chosen as the date after which no further specific reinvestment opportunity is available to any of the investment streams under comparison" (1971, p. 243). This is for the researchers to decide, considering the increasing uncertainty of the reinvestment opportunity over the future. The normalization procedure thus cannot avoid this arbitrariness. Allen calculated the normalized internal rates of return, setting the common investment period at forty-nine years. Now let us assume that the common period is twenty-five years. The normalized internal rates of return for the autarky case before and after the Assigned Experiment System are 17.5% and 27.7%, respectively. They are higher

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than Allen's estimates, though the ranking of two projects does not reverse.

In addition to this ambiguity in the determination of the common investment period, the normalization procedure has another shortcoming. As Allen himself pointed out, as the common period becomes longer the normalized internal rate of return approaches the assumed rate of return of the reinvestment opportunity. It implies that the normalization procedure will not be effective as an investment criterion to evaluate the alternative projects having the very long investment periods because the normalized internal rate of return of any investment stream becomes almost equal to the rate of return of the reinvestment for a sufficiently long period. Thus, the normalization procedure does not seem appropriate in the case of our study where the period between the first expenditure and the last return is very long.

Above discussions do not imply that conventional investment criteria are superior to the normalization procedure. Any available investment criteria including the normalization procedure cannot avoid arbitrariness. It seems safe, at present, to try alternative investment criteria in order to see if any inconsistency might be involved. In our case, it is shown that investment in rice breeding was highly profitable and the ranking of investments before and after the Assigned Experiment System is unique irrespective of the alternative investment criteria used.

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Publications

Books Reviewed

Chenery, Hollis, Montek S. Ahluwalia, C. L. G. Bell, John H. Duloy, and Richard Jolly. *Redistribution with Growth*. New York and London: Oxford University Press, 1974, xx + 304 pp., $5.00 paper.

Most economists interested in development assistance and planning will want to read this book. It brings into sharp focus income distribution problems, presents a number of new ideas, and has some notions which are quite controversial. Earlier versions of the twenty papers included in the volume were discussed at a 1973 Workshop in Bellagio, Italy, sponsored by the International Bank for Reconstruction and Development and the Institute of Development Studies, University of Sussex. The "state of the arts" regarding income distribution and employment in low income countries is its focus. The first eight papers in the book discuss the extent of worldwide poverty and also argue that development activities should be reoriented to more favorably affect the poor. The next five papers concentrate on problems of quantifying and modeling income distribution issues. The final seven papers summarize the recent experience of India, Cuba, Tanzania, Sri Lanka, South Korea, and Taiwan with growth and income distribution.

The main conclusion of the volume is that employment and income distribution objectives must become explicit elements in development strategies. This is supported by three principal arguments. First, up to one-third of the population in low income countries, especially rural people, have not benefited from recent rapid economic growth. Second, despite a dismal overall record, a handful of low income countries have instituted policies over the past three decades which led to equitable sharing of income growth among most economic classes. Third, income concentration and its twin, asset ownership concentration, can be treated best by reallocating public investments toward the poor.

The book is fairly comprehensive in its coverage of issues. Some significant gaps can be noted, nevertheless. Almost all of the discussion, for example, centers on intracountry income distribution questions; only one paper treats income disparities between countries. More importantly, the discussion of policy alternatives for changing income distribution overlooks several important areas of intervention. Extensive discussions of factor markets, ownership and control of assets, taxation, public consumption goods, commodity markets, and new technology are presented. The impact of inflation, exchange rate policies, and financial market policies are largely ignored, however. In many cases these latter factors may have a more serious impact on income distribution than the seven alternatives discussed. Inflation can be a very regressive form of "taxation." Likewise, concessional interest rates in financial markets can result in the poor being barred from access to low priced credit as well as being denied fair rates of return on financial savings. Distorted exchange rates have often depressed incomes of particular economic classes. The presentation would have been strengthened if these topics had also been considered.

Depending on the brand of economics they preach, readers are likely to have strongly positive or equally strong negative reactions to this book. Free enterprise advocates will feel comfortable with the volume, and conclude that it gives new direction to development aid. They will view it as a logical and useful extension of neoclassical arguments over the past three decades which have stressed that the size of the economic pie in low income countries must be expanded before it is resliced, that in initial phases of growth incomes must be concentrated in the hands of "savers" represented by the state and industrial entrepreneurs so that capital formation will be accelerated, and that only in later stages of growth can low income countries afford to divert resources to easing poverty. *Redistribution with Growth* along with other new literature on this topic might be cited as an indication that growth policies have succeeded in many low income areas, that the IBRD does have a heart, and that reslicing time has arrived. (It might also indicate that some of the neoclassical assumptions about the importance of unequal income distribution may not have been correct.)

On the other hand, readers who view development as a class struggle over control of economic surpluses and asset ownership will likely have strongly negative reactions to the book. They might argue that "developmental aid" during the past three decades, ostensibly to stimulate growth in low income countries, was really aimed at reinforcing the status quo. It was payment made to the politically powerful in these countries to assure market access and friendly treatment of transnational business interests. Bribes in low as well as high income countries, overpriced aid goods, aid withdrawals when the tentacles of capitalism were threatened, and heavy emphasis in aid programs on suppressing internal unrest could be cited as evidence. They might further argue that the income distribution channels of most political economies are indelibly stamped on the fabric of the society

and that these channels can only be redirected by rending and reweaving the main power components in the society. *Redistribution with Growth* will be viewed by this group as just window dressing in the capitalist's storefront.

My own feelings are mixed after reading *Redistribution with Growth*. I am glad, for example, to see the IBRD lend its influence to programs of income redistribution—a change in policy which is long overdue. I also like the "can-do" attitude which the book conveys. It assumes that neoclassical economics may be able to say something useful about poverty questions. The IBRD's new concern with income distribution may significantly influence some decision makers in low income countries. I suspect, however, that there are serious political commitments to more equitable income distribution in all too few countries. In many cases asset ownership along with political and police power must be reorganized through major revolutions. The major challenge to be faced during the next couple of decades by the "development set" will be relating positively to societies which are going through these revolutions.

Dale W. Adams
Ohio State University

Dick, Daniel T. *Pollution, Congestion, and Nuisance*. Lexington, Mass.: D.C. Heath Co., 1974, xii + 177 pp., $12.50.

This is a book about externalities. It is a review and restatement of the concepts from recent literature in the area. Mathematical models of constrained optimization are used extensively to develop the concepts under the assumption that a Pareto optimal allocation of resources maximizes the social product. An understanding of optimization techniques from calculus and mathematical programming is assumed. A word of caution is needed concerning the title of the book since the terms, especially nuisance, are not defined as they are commonly used. The terms, however, are adequately defined.

The approach is to divide externalities into two categories on the basis of whether the externality can or cannot be abated. Nuisances are externalities which cannot be abated except by eliminating the activity, while pollution and congestion are abatable, generally by investment in abatement equipment. In the latter, more important case residuals are considered as inputs in the production process and, hence, can be substituted for other inputs.

The author starts with an admission that his selection of Pareto optimality in resource allocation is a value judgment. Fortunately, he does not make the further judgment that all adjustments should be Pareto safe; i.e., his procedure allows that the polluter or victim can be made worse off if social product can be improved. Next, in chapter 2, a mathematical programming model is used to develop the conditions of market behavior in an optimal sense by assuming actor independence, i.e., the absence of externalities.

Chapter 3 considers the theoretical aspects of nuisance, nonabatable externalities, and chapter 4 considers the theoretical aspects for the pollution-congestion case. It is shown that the existence of externalities in both cases leads to Paretian nonoptimal solutions but that, in the former, market structure matters.

Chapters 5 and 6 deal with "policy" alternatives for the two cases. The nuisance case focuses on the optimal level of consumption and production while the pollution case focuses on balancing abatement costs and the damages from pollution. The policy alternatives considered are voluntary, bargaining or merger, and involuntary, taxes, subsidies, prohibitions, and directives (standards). Although considerable discussion is devoted to the voluntary approach, such procedures are not very useful—if they worked under present rules the problems would not exist. The preferred method seems to be taxes, as advocated since Pigou. However, informational requirements are burdensome. While subsidies should work equally well, several practical problems exist in their use. Prohibition can work, as well as regulation, but the latter requires information comparable to effective taxation.

Chapter 7 is used to briefly discuss one type of general equilibrium model, the Russell-Spofford model, and one approach to dynamics in considering externaltiies, the maximum principle. These do little more than whet the appetite for something other than the partial equilibrium models used in the rest of the book.

Overall, the material that the author selected to evaluate is treated very adequately. The presentations generally are clear and concise and the mathematical models relatively easily followed. The book reviews and summarizes much of the important recent work in the area of externalities (especially that related to the environment) as economists have typically viewed the topic. It should be useful to specialists in the area and as a source for graduate courses dealing with the topic.

The major question concerning the usefulness of the material stems from the value judgment that efficiency from the standpoint of Paretian optimality is the appropriate objective. While the author does not opt for Pareto safe adjustments, it must be remembered that the Pareto optimum resource allocation depends on the given prices and that these vary with the initial distribution of resources (wealth and incomes). Each different set of initial allocations will result in a different set of optimal allocations. While we must start from existing conditions we are not bound by them to the extent of legitimizing the current distribution. Mishan in his 1971 review of the literature on externalities concludes: "It is not, of course, hard to understand the somewhat exaggerated weight attached by economists to the allocative aspects of an economic problem as distinct, say, from those

connected with equity. For the former aspects lend themselves nicely to formal theorizing and, with patience and a little finesse, impressive measures of social losses and gains can be foisted on credulous civil servants and a gullible public" (p. 26).

Allocative efficiency is an important aspect but there should not be undue concentration on that criterion to the exclusion of others. However, many useful insights into the problems of pollution and pollution abatement have evolved from the discussions and arguments dealing with optimal resource allocation models. Perhaps little more can be asked of research in such complicated social science problem areas.

Dale Colyer
West Virginia University

Reference

Mishan, E. J. "The Postwar Literature on Externalities: An Interpretive Essay." *J. Econ. Lit.* 9 (1971):1–28.

Books Received

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Dean, G. W., M. De Benedictis, G. Fabiani, R. Fanfani, and **G. Marenco.** *Il Mezzogiorno Estensivo E La Ristrutturazione Dell'Agricoltura*. Milan: Franco Angeli Editore, 1974, 326 pp., price unknown.

Elliott, Charles. *Patterns of Poverty in the Third World*. New York: Praeger Publishers, 1975, xii + 416 pp., $25.00, $6.95 student edition.

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Frederick, Kenneth D. *Water Management and Agricultural Development*. Baltimore: Johns Hopkins University Press, 1975, xiv + 187 pp., $10.00.

Friedmann, John, and **William Alonso.** *Regional Policy Readings in Theory and Applications*. Cambridge: M.I.T. Press, 1975, xxi + 808 pp., $22.50.

Fuller, Wallace H. *Management of Southwestern Desert Soils*. Tucson: University of Arizona, 1975, x + 195 pp., $7.50.

———. *Soils of the Desert Southwest*. Tucson: University of Arizona, 1975, xv + 102 pp., $4.95.

Fullerton, Herbert H., and **James R. Prescott.** *An Economic Simulation Model for Regional Development Planning*. Ann Arbor: Ann Arbor Science Publishers, 1975, viii + 133 pp., $12.50.

Gregersen, Hans M. *U.S. Investment in the Forest-Based Sector in Latin America*. Baltimore: Johns Hopkins University Press, 1975, xi + 113 pp., $4.50 paper.

Grilli, Enzo R. *The Future for Hard Fibers and Competition from Synthetics*. Baltimore: Johns Hopkins University Press, 1975, xii + 108 pp., $5.00.

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Karvis, Irving B., Zoltan Kenessey, Alan Heston, and **Robert Summers.** *A System of International Comparisons of Gross Product and Purchasing Power*. Baltimore: Johns Hopkins University Press, 1975, xi + 294 pp., $20.00, $7.50 paper.

Kennedy, Peter. *Macroeconomics*. Boston: Allyn & Bacon, 1975, x + 422 pp., price unknown.

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MacMillan, James A., Chang-mei Lu, and **Charles F. Framingham.** *Manitoba Interlake Area*. Iowa: Iowa State University Press, 1975, 162 pp., $4.95.

McNamara, Robert S. *The Assault On World Poverty*. Baltimore: Johns Hopkins University Press, 1975, xi + 425 pp., $17.50, $5.95 paper.

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———. *Papers-Workshop on Evaluating State Title V Pilot Programs in the Northeast*. Publ. 4, Cornell University, 1974, ii + 70 pp., $1.00.

———. *The Proceedings of the Conference on Rural Land-Use Policy in the Northeast*. Publ. 5, Cornell University, 1974, ix + 279 pp., $3.00.

Prescott, James R., and **Cris W. Lewis.** *Urban-Regional Economic Growth and Policy*. Ann Arbor: Ann Arbor Science Publishers, 1975, x + 220 pp., $12.50.

Reynolds, John E., Martin J. Redfern, and **Robert N. Shulstad.** *Readings in Natural Resource Economics*. New York: MSS Information Corp., 1974, 199 pp., $11.00, $5.00 review copy.

Roberts, E. F. *A Basic Introduction to Land Use Control Law and Doctrine.* Northeast Regional Center for Rural Development, Publ. 6, Cornell University, 1974, iv + 41 pp., $1.00.

Srivastava, Uma K., Earl O. Heady, Keith D. Rogers, and **Leo V. Mayer.** *Food Aid and International Economic Growth.* Ames: Iowa State University Press, 1975, viii + 160 pp., $7.95.

Tannenbaum, Steven R., and **Daniel I. C. Wang.** *Single-Cell Protein II.* Cambridge: M.I.T. Press, 1975, ix + 707 pp., $20.00.

Weinrich, A. K., and **Sister Mary Aquina O. P.** *African Farmers in Rhodesia.* London: Oxford University Press, 1975, x + 342 pp., $22.00.

Woodroof, Jasper Guy, and **Bor Shiun Luh.** *Commercial Fruit Processing.* Westport, Conn.: Avi Publishing Co., 1975, x + 710 pp., $39.00.

News

Announcements

Winter Meeting

The Allied Social Science Associations meeting will be held in Dallas, Texas, December 28–30, 1975. The program presented by the American Agricultural Economics Association will include papers on national food policy, financial responses to market risks, and the economic organization of socialist agriculture. Most program details were carried in the August issue. Clifford Hildreth, University of Minnesota, Konrad Biedermann, Continental Grain Company, and Richard Sandor, Chicago Board of Trade, will be the discussants for the market risks session. Two additional papers have been added to the socialist agriculture session; they are "Economic Models of Socialist Agriculture: The Soviet Case" by James Millar, University of Illinois, and "The Socialist Organizational Model and the Developing Economies" by Robert Stuart, Rutgers University.

Membership and Subscriptions

Effective January 1, 1976, regular membership dues for the American Agricultural Economics Association will be $25 per year, and junior memberships for students will be $12.50. The institutional and nonmember subscription rate will be $35.

The directors of the AAEA have also added a new class of membership designed for senior members. The dues will be $12.50 per year. Senior membership will be open to individuals, upon written request, who are sixty-five years of age or older and have retired from active professional work.

Erratum

The transfer matrix in "A Spatial and Temporal Model of the North American Pork Sector for the Evaluation of Policy Alternatives" by Larry Martin and Anthony C. Zwart which appeared in the February 1975 issue of the *Journal* (p. 62) was printed incorrectly. The correct form is as follows:

$$\begin{bmatrix}
1 & & & 1 & & & & 1 & & \\
& 1 & & & 1 & & \cdots & & 1 & \\
& & \ddots & & & \ddots & & & & \ddots \\
& & 1 & & & 1 & & & & 1 \\
-1 & -1 \cdots & -1 & & & & & & & \\
& & & -1 & -1 \cdots & -1 & & & & \\
& & & & & & \ddots & & & \\
& & & & & & & -1 & -1 \cdots & -1
\end{bmatrix}$$

Agricultural Records Available

The papers of Senator Carl T. Hayden of Arizona who served in the United States Congress from 1912–68, are now open for use by researchers in the Department of Special Collections of the Arizona State University Library. This voluminous collection of approximately 1000 linear feet of records was indexed over a three-year period and contains materials on a broad range of subjects of interest to agriculturists. Included are records related to federal water and power legislation throughout the western United States and northern Mexico, utilization of public lands, and reclamation. For more information contact Charles C. Colley, Head of Special Collections, Arizona State University Library, Tempe, Arizona 85281.

International Housing Symposium

Clemson University and the International Association for Housing Science will present the International Symposium on Lower-Cost Housing Problems, May 24–28, 1976 at the Regency Hyatt Atlanta Hotel, Atlanta, Georgia. The symposium is a nonprofit academic activity designed to generate interest in housing problems and to disseminate information related to different aspects of housing. There will be nearly 100 speakers from more than twenty countries. All papers will be reviewed by a committee of housing specialists before they are delivered. The symposium is open to all persons interested in the many aspects of housing science and production. For more information, write Herbert W. Busching, Head, Department of Civil Engineering, Clemson University, Clemson, South Carolina 29631.

Travel Grants for IAAE Conference

The American Agricultural Economics Association has allocated $5000, which is matched by the Fund for the International Conference of Agricultural Economists, to provide $10,000 for partial financing of travel to the sixteenth Conference of the International Association of Agricultural Economists in Nairobi, Kenya, July 26–August 4, 1976. The AAEA in cooperation with the U.S. Council of the IAAE will appoint a four-person joint committee to select the grant recipients. The primary purpose of the travel grants is to encourage younger agricultural economists to attend. Grants will be limited to some

fraction of air fare from the United States to Nairobi.

To be eligible applicants must be members of the AAEA, 35 years of age or less, and have some international interest (it need not be one's primary focus) and a potential for professional growth. The deadline for applications is February 1, 1976. No application forms are used. Letters of application with supporting vitae and any solicited letters of recommendation should be sent to the chairman of the Selection Committee: M. Louis Upchurch, Department of Food and Resource Economics, McCarty Hall, University of Florida, Gainesville, Florida 32611.

Persons not meeting the criteria are welcome to apply and will be considered if additional monies are available from other sources.

Competition for Contributed Papers at IAAE Conference

A competition for contributed papers is being arranged in connection with the 1976 Conference of the International Association of Agricultural Economists. Entries are invited from members or nonmembers on topics in any field of agricultural economics. Closing date for submission of papers is February 15, 1976. Further particulars are available from IAAE country correspondents or directly from Kenneth R. Farrell, Deputy Administrator, Economic Research Service, United States Department of Agriculture, Washington, D.C. 20250.

Nominating Committee

The following individuals have been appointed by James T. Bonnen, president of the American Agricultural Economics Association, to serve on a committee to nominate persons to fill vacancies in the offices of the AAEA for the year beginning August 1976: James Nielson, chairman, Washington State University; Glenn C. Himes, Ohio State University; Richard J. McConnen, Montana State University; Ted Rice, Continental Grain Company, New York; Fred H. Tyner, Mississippi State University; T. K. Warley, University of Guelph; and William Motes, Economic Research Service, U.S. Department of Agriculture. Nominations for president and for directors should be submitted to James Nielson by December 10, 1975.

AAEA Awards Program

Through its awards program the American Agricultural Economics Association recognizes professional excellence in several subfields of agricultural economics. The Association recognizes professional achievement at the student, the young professional, and the more experienced levels, in research, teaching, and extension activities. Sixteen awards will be presented in 1976.

The program has a rich tradition as can readily be noted by a review of the roster of award winners over the years. Your Association believes that this tradition will be continued in the 1976 program.

The 1976 program has been organized and will be conducted by ten committees representing a substantial professional input of nearly 100 committee members. We hope you will submit nominations for the categories outlined in this announcement. The general awards chairman is Paul L. Kelley, Kansas State University.

Distinguished Extension Program

The distinguished extension program awards recognize achievement of excellence in extension economics teaching programs. Two awards are offered in 1976. One award will be given to an individual with less than ten years experience in extension education, and the other award will go to an individual with ten or more years of experience in extension education.

Nomination. Nominations may be made by any member(s) of the AAEA and selection will be made from among those nominated. The nominee must have been active in extension teaching for at least one year at the time of the nomination, and the content of teaching efforts must be principally in the field of agricultural economics. Each nomination must be made by separate letter accompanied by eight copies of documentary evidence indicating nominee's name and extension title; extension program area in which teaching is conducted; identification of the clientele served; objectives of the educational program; teaching techniques, educational methods, and materials utilized; and effectiveness of the extension teaching effort in terms of clientele response and/or establishment of the utility of the extension teaching program.

Evaluation. Each nominee will be evaluated on the quality of work as indicated by the documentary evidence submitted with the nomination relative to the following characteristics: effectiveness in teaching application of economic principles and tools of analysis appropriate to the problem and audience involved; ability to conceptualize new extension educational programs and application of new teaching concepts to existing programs; effectiveness in bringing about significant behavioral change and/or understanding of clientele; and contribution to improved extension teaching in agricultural economics as evidenced by participation in appropriate professional activities and organizations.

Due dates. Nominations and supporting evidence must be submitted by February 1, 1976 to the subcommittee chairman: Everett Peterson, Department of Agricultural Economics, University of

Nebraska, Lincoln, Nebraska 68508. Recommendations of the subcommittee will be forwarded to the general awards chairman by May 15, 1976.

Distinguished Undergraduate Teaching

The distinguished undergraduate teaching awards recognize and encourage meritorious performance in undergraduate teaching in agricultural economics. Two awards will be given: one for an individual with less than ten years of experience as an undergraduate teacher, and one for an individual with ten or more years of experience as an undergraduate teacher.

Nomination. Nominations may be submitted by any member(s) of AAEA. Winners will be selected based entirely on the supportive material submitted. Renominations are invited providing the supporting evidence is updated and resubmitted. Nominees must be actively engaged in teaching at a professional level during the 1975–76 school year. Nominees must have demonstrated outstanding ability as an undergraduate teacher of agricultural economics. The format of the nomination material submitted should use as primary categories the five major criteria areas listed in the evaluation criteria section which follows. Include biographical data of the nominee—name, present position, education, number of years of university-college teaching and experience in the profession. Supporting evidence must be limited to three pages for each of the five primary categories of the nomination. No more than three letters of reference from peers and students for each of the five primary categories should be included. Adjunct material may be included as an appendage to the nomination package if desired; for example, summaries of student class evaluations for courses taught. Eight copies of each nomination package are required.

Evaluation. Five major criteria areas will be used in evaluating nominations with relative weights as follows. (*a*) Quality of teaching (45%)—ability to motivate and stimulate student to learn (20%); innovation for presentation, evaluation measurements (15%); and mastery of subject, use and application to business conditions (10%). (*b*) Academic advising, counseling and extracurricular activities of students (20%)—advising and counseling (14%); and catalyzing extracurricular activities of students, i.e., department clubs or organizations, student council or senate, student publications, convocations, seminars, community involvement (6%). (*c*) Campus participation in instructional, course and curricular improvement efforts (15%)—department, college; and university-wide. (*d*) Professional improvement in teaching for benefit of self and peers (15%)—published textbooks, manuals, bulletins (5%); research papers related to improved teaching (5%); and participation in professional meetings and committees related to improved teaching and student activities (5%). (*e*) Department/college/university teaching awards (5%)—student association/alumni awards.

Due dates. Nominations and supporting evidence must be sent by February 1, 1976 to the chairman of the distinguished undergraduate teaching awards subcommittee: R. G. F. Spitze, Department of Agricultural Economics, University of Illinois, Champaign-Urbana, Illinois 61801. Recommendations of the subcommittee will be forwarded to the general awards chairman by May 15, 1976.

Outstanding Master's Degree Program

The outstanding master's degree program awards have as their objective development of professional excellence by individuals pursuing master's degree programs in agricultural economics. Three awards are offered. A cash supplement of $250 accompanies each award.

Nomination. Any department engaged in training agricultural economists at the master's degree level may submit nominations. Entries must be submitted by the head of the department where the degree is earned. A department may submit one nomination for each fifteen master's degree candidates or fraction thereof presented to a graduate school faculty during the year. To determine the number of eligible candidates, departments should limit consideration to candidates who will receive a degree in agricultural economics and to candidates who have taken agricultural economics as a field of emphasis. Nominations should include thesis or other comparable documentation. Selection will be made from documentation approved in final form by the student's advisory committee during the calendar year 1975, provided the candidate has met all other formal requirements for the master's degree. A published thesis may be entered in both the published research and master's program classes but will be eligible for only one award. Although a published thesis is acceptable, a copy of the thesis as submitted to the graduate faculty should be sent whenever possible. Three copies of all nomination materials (i.e., thesis) are required to be sent to the committee chairman. All copies will be returned after reading by the judges.

Evaluation. Copies of evaluation criteria may be obtained from any member of the subcommittee.

Due dates. All nominations and documentation should be sent by February 1, 1976 to the chairman of the outstanding master's degree award subcommittee: Joseph Havlicek, Jr., Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061. Recommendations of the subcommittee will be for-

warded to the general awards committee chairman by May 15, 1976.

Outstanding Doctoral Degree Program Award

The outstanding doctoral degree program awards are given in recognition of development of professional excellence for persons pursuing a doctoral program in agricultural economics. Three awards will be given in 1976. A cash supplement of $250 accompanies each award.

Nomination. Entries must be submitted by the head of the department where the thesis or comparable document was presented in partial fulfillment of requirements for a degree. A department may submit one nomination for each twelve doctoral candidates or fraction thereof presented in agricultural economics to a graduate school faculty during the year. To determine the number of eligible nominations, departments should limit consideration to candidates who received a degree in agricultural economics and to candidates who have taken agricultural economics as a field of emphasis. Selection will be made from theses (or comparable documents) approved in final form by the students' advisory committees during the calendar year 1975, provided the candidate has met all other formal requirements for the doctoral degree. A published thesis may be entered in both the published research and thesis categories but will be eligible for only one award. Although a published thesis is acceptable, a copy of the thesis as submitted to the graduate faculty should be sent whenever possible. Three copies of a thesis must be sent to the subcommittee chairman. All copies will be returned after they have been read by the judges.

Evaluation. Criteria for evaluation of nominations may be obtained from any member of the subcommittee.

Due dates. Nominations and supporting evidence should be sent by February 1, 1976 to the chairman of the outstanding doctoral thesis award subcommittee: Forrest E. Walters, Department of Economics, Colorado State University, Fort Collins, Colorado 80521. Recommendations of the subcommittee will be forwarded to the general awards chairman by May 15, 1976.

Quality of Research Discovery

This and the following three awards are given to encourage excellence in publications in all areas of agricultural economics.

Rules. There are no requirements regarding the number of authors or professional experience. Nominations may be submitted by individuals, departments, or agencies. Nine copies of each publication should be submitted, unless expense for the individual is excessive. Return of the publications is not customary but can be requested. Nominations should be submitted for only one award in either the quality of research discovery or quality of communication category for 1975.

Nomination. A maximum of two awards are given. Entries must specify that the nomination is to be judged for the quality of research discovery. Entries must have been published in 1975.

Evaluation. The research must be a significant contribution to the field of knowledge in agricultural economics. The work should demonstrate excellence in research methodology and may deal with conceptualization of researchable problems as well as empirical verification.

Due dates. Entries should be sent by February 1, 1976 to the subcommittee chairman: A. Gordon Ball, College of Agriculture, University of Guelph, Guelph, Ontario, Canada N16 2W1. Recommendations of the subcommittee will be forwarded to the general awards chairman by May 15, 1976.

Quality of Communication

The rules pertaining to the award for quality of research discovery also apply to this award for quality of communication.

Nomination. A maximum of two awards will be given. Entries must specify that the entry is to be judged for its quality of communication. Entries must have been published in 1975.

Evaluation. Entries must demonstrate superior communication of concepts or knowledge in any subject matter area or professional specialization (i.e., research, teaching, or extension) in agricultural economics to a specified audience. If dealing with transmission of research findings, the publication need not contain the author's original research but should improve communication within the profession as well as between it and other professions.

Due dates. Entries should be forwarded by February 1, 1976 to the subcommittee chairman: A. Gordon Ball, College of Agriculture, University of Guelph, Guelph, Ontario, Canada N16 2W1. Recommendations of the committee will be forwarded to the general awards chairman by May 15, 1976.

Publication of Enduring Quality

One award is offered for a publication with a publication date during the fifteen-year period 1951–65. Entries are judged on the basis of the enduring quality of their contribution to the profession.

Eligible entries are articles in this *Journal* (during

part of the period considered, the *Journal* was known as the *Journal of Farm Economics*) regardless of whether the authors are AAEA members, and also other publications by authors, one of whom was a member of the AAEA at the time of publication. Entries must be submitted by departments or other administrative units, by colleagues, or by the authors themselves. Publications receiving an award in any other category in previous years are eligible for this award.

Entries should be sent by February 1, 1976 to the subcommittee chairman: Vernon Eidman, Department of Agricultural Economics, University of Minnesota, St. Paul, Minnesota 55455. Nine copies of the publication should accompany the entry. Recommendations will be forwarded to the general awards chairman by May 15, 1976.

Outstanding Journal Article

The editor and editorial council of the *Journal,* with the editor as chairman, will choose the outstanding article in the 1975 volume of the *Journal.*

AAEA Fellow

Nominations for AAEA Fellow should be sent to the Secretary-Treasurer, John C. Redman, University of Kentucky, Lexington by December 1, 1975. Documentation is needed to support the nomination. Selection is made by a committee of Fellows (see *Amer. J. Agr. Econ. Handb.-Dir.* 54 (1972): 424).

Browning Award

The Browning Award is presented annually to an individual who has made an outstanding contribution to the improvement of world food resources anywhere in the world. A $5,000 check accompanies the award. Society membership or affiliation is not required. However, each nomination must be sponsored by a recognized professional association or society. Age is not a criterion, but achievements must have been completed within the past ten years. Nominations should be sent to the subcommittee chairman: Lowell S. Hardin, Ford Foundation, 320 East 43rd Street, New York, New York 10017. Nominations are then forwarded by the AAEA president or his delegate to the president of the American Society of Agronomy who administers the annual award selection. Funds for the award were originally provided by Edward West Browning and are now administered by the New York Community Trust.

General Recognition

Awards will be presented at the annual AAEA awards program during the annual meeting at Pennsylvania State University, August 15–18, 1976. Winners will be identified in the annual meeting awards program brochure and in the December proceedings issue of the *Journal.*

Personnel

University of Alberta

Appointment: Melville L. McMillan, formerly at the University of Wisconsin-Madison, is an associate professor of economics.

University of Arizona

Appointment: R. O. P. Farrish, head of the Department of Agricultural Economics, University of Connecticut, is a visiting professor, 1975–76.

University of California-Davis

Appointments: Richard D. Green, formerly at Montana State University, **Richard E. Howitt,** Ph.D. University of California-Davis, and **Lawrence E. Shepard,** Ph.D. University of California-Santa Barbara, are assistant professors of agricultural economics; **Robert Jacobson,** on leave from Ohio State University, is a visiting professor in dairy marketing extension, 1975–76; **Samuel H. Logan,** professor of agricultural economics, is associate dean of Graduate Administration; **Joseph N. Uhl,** on leave from Purdue University, is a visiting professor in agricultural economics and the interdisciplinary consumer science group, 1975–76.

Canada Agriculture

Appointments: George J. Conneman, on leave as professor of agricultural economics, Cornell University, fall 1975; **Warren Lee,** on leave from Ohio State University, is researching agricultural credit and finance, 1975–76.

Clemson University

Appointment: Lynn A. Stanton, former assistant professor of farm management and an extension economist, University of Georgia, is an assistant professor of agricultural economics and rural sociology with extension farm management responsibilities.

University of Connecticut

Appointment: J. William Levedahl, former assistant professor, Bradley University, is an assistant professor of agricultural economics.
Honor: D. J. Stitts, associate professor, has been elected president-elect of the Northeast Agricultural Economics Council, 1975–76.

Cornell University

Appointment: Dharm Narain, chairman of the Agriculture Commission, Ministry of Agriculture, India, is a visiting professor.
Honor: George G. Conneman, professor of agricultural economics, received the Professor of Merit award, 1975.

University of Florida

Retirements: Kenneth M. Gilbraith, R. E. L. Green, and **Clyde E. Murphree** have left within the past year.
Honor: Edwin H. Finlaysin, instructor, has been named Teacher of the Year, 1975 by the Student Agricultural Council in the College of Agriculture.

University of Guelph

Appointment: Elmer L. Menzie, formerly at the University of Arizona, is director of the School of Agricultural Economics and Extension Education.

University of Idaho

Appointment: Lawrence Conklin, M.S. Colorado State University, and **Terry Nelson,** M.S. University of Minnesota, are research associates; **James R. Jones,** Ph.D. University of Arkansas, and **G. Ray Prigge,** Ph.D. Ohio State University, are assistant professors.

University of Illinois

Appointment: Daniel I. Padberg, former professor of agricultural economics, Cornell University, is a professor and head of the Department of Agricultural Economics.
Leaves: B. L. Brooks, H. D. Guither, J. H. Herbst, and **E. R. Swanson.**

Iowa State University

Appointments: James W. Eiler and **Loren W. Tauer** are instructors of economics; **Kenneth J. Nicol** is an assistant professor in the Department of Economics and the Center for Agriculture and Rural Development; **Doyle V. Peterson** is a research associate in the Department of Economics; **Stephen H. Sosnick,** on leave from the University of California-Davis, is a visiting professor continuing on the program in Peru

sponsored by the Agency for International Development.

Kansas State University

Appointments: Dean Parker, M.S. University of Nebraska, and **Duane Strickler,** M.S. Kansas State University, are farm management association fieldmen stationed at Concordia, Kansas and Garnett, Kansas, respectively.
Resignation: Vaughn Nelson, former farm management association fieldman.

University of Kentucky

Appointment: Lynn Robbins, Ph.D. Michigan State University, is an assistant professor of agricultural economics.
Return: Barry W. Bobst, is back from a two-year assignment with the University of Kentucky-Agency for International Development team in Khon Kaen, Thailand.

Michigan State University

Appointments: Myron Kelsey is a project leader in farm management extension; **Ahkter Hameed Khan,** on leave from the Rural Development Academy, Pakistan, is a visiting professor; **Stephen Meyer,** LL.D. University of Michigan, is a specialist in the Departments of Agricultural Economics and Resource Development; **Donald Ricks** is a project leader in marketing extension; **Dunstan Spencer,** on leave from Njala University College, is a visiting professor, 1975–76.
Retirement: Leonard Kyle, former professor of agricultural economics and project leader in farm management extension.

Mississippi State University

Appointment: Bobby R. Eddleman, former professor and director of the Center For Rural Development, University of Florida, is a professor and economist in farm management.
Honor: James H. Simpson, associate professor of agricultural economics, received the 1975 award of merit for teaching from Gamma Sigma Delta.

Oklahoma State University

Appointment: James R. Nelson, formerly at the University of Idaho, is an associate professor of agricultural economics with extension and research responsibilities in rural development.
Return: Robert E. Daugherty is back as an associate professor of extension livestock marketing after two years in Tehran, Iran as livestock advisor to the Ministry of Agriculture.

Purdue University

Appointments: Wilmer A. Dahl and **James K. Whittaker** are assistant professors of agricultural economics.
Return: G. Edward Schuh, is back after a year as a senior staff economist for the Council of Economic Advisors in Washington, D.C.

Texas A&M University

Appointment: John B. Penson, Jr., formerly at Purdue University, is in the Department of Agricultural Economics.

U.S. Department of Agriculture

Appointments: Nicolaas Bouwes is a national resource economist for the National Resource Economic Division of the Economic Research Service stationed in Madison, Wisconsin; **William Crowley,** formerly with NRED in Washington, D.C., is an adjunct assistant professor at Michigan State University with NRED; **Larry Hamm,** Ph.D. candidate Michigan State University, is with the National Economic Analysis Division of ERS and an adjunct instructor at Michigan State University.

Utah State University

Appointment: Terry Glover, formerly at Ohio State University, is an assistant professor of agricultural economics.
Returns: Lloyd Clement is back from Texas A&M University; **Leon Michaleson** is back from Bolivia and is working with extension; **Morris Whitaker** is back from a two-year leave in Bolivia, is taking an extended assignment, and returning to Bolivia for another year.

Virginia Polytechnic Institute and State University

Appointment: Jerry W. Looney, a lawyer from Arkansas, is a visiting instructor.

Washington State University

Appointment: Kenneth C. Gibbs, associate professor, University of Florida, is working on a project involving Irrigation Development, 1975–76; **Gayle Willett** is an extension economist.
Reassignment: Martin V. Waananen, former profes-

sor of agricultural economics, is the assistant instructor of resident instruction for the College of Agriculture.

University of Wisconsin

Appointment: Richard Weigle is statewide chairman of agriculture and agribusiness programs, University of Wisconsin-Extension.
Return: Hugh Cook is back after a two-year leave as head of the Department of Agricultural Economics, University of Ife, Western State Nigeria under a University of Wisconsin-Agency for International Development contract. (Please note that this information was incorrect as printed in the May 1975 issue.)
Honor: Wilmer A. Dahl, Ph.D. University of Wisconsin, was given the Nourse award by the American Institute of Cooperation for the best doctoral dissertation in 1974–75 on the subject of U.S. agricultural cooperatives.

University of Wyoming

Appointments: Richard M. Adams, Ph.D. University of California-Davis, is an assistant professor of resource economics; **Robert D. Carver,** formerly at North Dakota State University, is an associate professor of agricultural economics and an extension marketing economist.

Other Appointments

Joe F. Baldwin, M.S. University of Arkansas, is with the Central Land Bank, St. Louis.
David Cole, former associate professor of agricultural economics, Michigan State University, is the director of marketing, Hubbard Milling Company.
Kenneth D. Duft, on leave from Washington State University, is the chief economist for the Federal Bank for Cooperatives, Denver.
Marvin R. Duncan, Ph.D. Iowa State University, is an agricultural economist at the Federal Reserve Bank of Kansas City.
Charles E. French, on leave from Purdue University, is assistant director of the National Academy of Sciences Study focusing on U.S. research capabilities, world food production, and malnutrition.
A. Ronald Gallant, on leave from North Carolina State University, is a visiting assistant professor of business, University of Chicago, 1975–76.
Bruce L. Gardner, on leave from North Carolina State University, is a senior staff economist, President's Council of Economic Advisors, 1975–76.
Gordon Gemmill, Ph.D. Michigan State University, is on the faculty of Wye College.
Dana C. Goodrich, Jr., professor of marketing, Cornell University, is at the Institut Fur Gartenbauokonomie, Hanover, Germany.
Charles H. Gordan, M.S. Virginia Polytechnic Institute and State University, is with the Bank of the Cumberlands, Grundy, Virginia.
Jimmye Hillman, formerly at the University of Arizona, is with the Hazardous Materials Advisory Committee.
E. D. Kellogg, on leave from the University of Illinois, is with the Ford Foundation at Chiengmai University, Thailand.
William E. Martin, on leave from the University of Arizona, is with the Food Institute East-West Center, Honolulu.
Timothy D. Mount, on leave as associate professor of agricultural economics, Cornell University, is at the University of Manchester, 1975–76.
Keith Roberts, on leave from Ohio State University, is in Iran.
Frederick J. Smith, Oregon State University, an extension marine economist, is on the staff of the National Oceanic and Atmospheric Administration, Washington, D.C.
Robert S. Smith, on leave as professor of farm finance, Cornell University, is with the Farm Credit Bank, Springfield, Massachusetts, 1975–76.
William J. Uhrig, on leave from Purdue University, is with Cook and Company, Memphis, 1975–76.
Boyd Wennergren, on leave as professor of agricultural economics, Utah State University, is the chief of party, Consortium for International Development, in Bolivia.

Obituaries

Karl Brandt

Karl Brandt, professor emeritus and former director of the Food Research Institute at Stanford University, died on July 8, 1975 at the age of 76.

Brandt was born at Essen, Germany, on January 9, 1899. He graduated from Wurttenberg State College of Agriculture in 1921 and received a Ph.D. in Agriculture from the University of Berlin in 1926. In 1929 he was appointed professor of agriculture in the University of Berlin and director of the Institute for Agricultural Market Research. From 1925 to 1927, he served as chief appraiser and vice-president of the German Farm Tenants' Bank. He was agricultural advisor to the president of the German Short-Term Farm Credit Administration in 1928–29 and continued to serve as a member of that organization's Board of Trustees until 1933. He was also a member of a board of experts of the German Bank of Industrial Obligations from 1929 to 1933.

Political considerations dictated the most important step in Brandt's career when, upon the seizure of power by Hitler, he left Nazi Germany in 1933 to take up residence in the United States as professor of agricultural economics in the Graduate Faculty of Political and Social Sciences in the new School of Social Research in New York.

In 1938 Brandt was appointed professor of agricultural economics at the Food Research Institute, associate director in 1952, and director from 1962 to 1964. Thereafter, until he withdrew from active professional life, he served as a senior research fellow in the Hoover Institution at Stanford.

Karl Brandt was an eminently practical man with much experience in the realities of social and political life. As a young man, he investigated the milk supply of Berlin, ran a farmers' cooperative, and arbitrated tenancy cases. He served as an adviser to four German banks and as an organizer of cooperative credit facilities. After coming to the United States he served at various times as a consultant to the International Bank for Reconstruction and Development, the Food and Agriculture Organization of the United Nations, various foreign governments, and philanthropic foundations. From 1958 to 1961, he was a member of President Eisenhower's Council of Economic Advisors.

During the period when Brandt was at the Food Research Institute (1938–64) he published more than 120 articles on a range of topics embracing most economic aspects of farming, the economics of trade and production of fats and oils, wartime management of food and agriculture, and the agricultural economies of the United States, Western Europe, Algeria, the Belgian Congo, Colombia, Malaysia, and Uruguay. In 1939 he was interested in long-term shifts in human and natural resources; in 1941 he was writing about food as a political weapon; in 1945 he was concerned with the reconstruction of world agriculture; in 1945 he wrote about strategies for agricultural development with special attention to the third world; and in the 1960s he was concerned about stability and change in the world economic order. While at the Food Research Institute, Brandt also wrote several books including *The German Fat Plan and Its Economic Setting* (1938). *The Reconstruction of World Agriculture* (1945), and *The Management of Agriculture and Food in the German Occupied and Other Areas of Fortress Europe* (1953).

Brandt was elected president of the Western Farm Economics Association in 1943–44 and of the American Farm Economic Association in 1955–56. In 1964 he became a fellow of the American Farm Economic Association. He was also awarded an honorary doctorate by the University of Heidelberg and the Justus von Liebig Prize by the University of Kiel. He received the German Order of Merit, first class with star, from West Germany. He was the only American member of the French Academy of Agriculture and was one of the few Germans ever to receive the Order of Merit, France's highest award for civil service.

Brandt had a remarkable working understanding of American society based on keen observation, a retentive memory, and an understanding of people. He was impressed by "the subconscious memory of all people in Western industrial society that all of them originally came from the farm." At the same time that he emphasized the human and the personal in his analysis of contemporary affairs, he believed firmly that "economics must proceed from mingled empirical study and statement of hypotheses to testing of hypotheses and construction of theory" if history was to be understood.

Joseph Stancliffe Davis

Joseph Stancliffe Davis, professor emeritus and former director of the Food Research Institute at Stanford University, died on April 23, 1975 at the age of 89.

Davis was born on a small farm in Chester County, Pennsylvania, on November 5, 1885 and was awarded the Ph.D. by Harvard University in 1913. He served as a member of the Harvard faculty from 1913 to 1921, with an interruption for service on the Allied Maritime Transport Council in London, 1918–19. In July 1921, he became one of the three original directors of the Food Research Institute at Stanford University. That Institute was his primary concern until he became emeritus in 1952.

The twenty volumes of *Wheat Studies*, embodying the results of much of the Institute's research from 1922 to 1944, contain twelve special studies and

thirty-one survey and review issues of which Davis was author or coauthor. His first book, *Essays in the Early History of American Corporations*, was published in 1917; his last, *The World between the Wars*, was published in 1975.

From his earliest years as an economist, Davis was able to combine scholarly research of the highest quality with the strenuous demands of public service. He was a member of the staff of the Dawes Commission on Reparations in 1924, a member of a team studying the Fiscal and Economic Position of Mexico in 1928, chief economist of the Federal Farm Board in 1929 to 1931, a member of the Food and Nutrition Board of the National Research Council from 1940 to 1945, and of the Institute of Pacific Relations from 1941 to 1947. In 1955, three years after his official retirement, he was called to serve for nearly four years as a member of President Eisenhower's Council of Economic Advisors.

The years were also not without their honors. Dr. Davis was elected president both of the American Statistical Association and the American Farm Economic Association in 1936 and of the American Economic Association in 1944; in 1957 he was made one of the first fellows of the American Farm Economic Association.

Dr. Davis used to say that he felt more at home in research than in teaching and that he had no real gift for classroom teaching. He did in fact have a great gift for teaching—by a word here, a sharp question there, a turn of a phrase or an aphorism—and many young scholars found his probing interest in their research the finest reward they could wish for and the greatest possible stimulus to their best efforts.

Various of his published works are landmarks. The paper he presented to the Farm Economic Association at Laramie, Wyoming, in August 1949, entitled "Our Amazing Population Upsurge," was the opening salvo in his attack on accepted projections of the population of the United States, an attack that ended the interwar belief in a static American population. That paper resulted from Davis's thoroughness in research, his insistence on having the latest information, and his reluctance to trust standing estimates or received doctrines. He had been working for some time on a book on consumption economics, and as he reviewed population projections for the United States and compared them with current population figures he began to sense that something was wrong. As he probed more deeply into the matter, the book was set aside and he concentrated almost exclusively on the population question; it continued to be a matter of special interest into the 1960s.

An article of September 1934, entitled "Agricultural Fundamentalism," is a superb exposition and critique of beliefs then widely held—and still held in some circles—about the place of agriculture in national economies; it is a model essay, balanced, thoughtful, informed, and lucid.

A third article, published in July 1932, is particularly apt today. It is entitled "The Specter of Dearth of Food: History's Answer to Sir William Crooks." In his presidential address to the British Association for the Advancement of Science in 1898, Crooks had forecast a crisis in world food supplies by 1931. Davis concluded that "political and social factors, not natural or economic limitations, are the principal obstacles to continuous advance in the plane of living."

Joseph Davis was a teacher, as well as a devoted seeker after knowledge and a loyal servant of his society. As he taught himself, he taught others, and his persistent emphasis on "expressing findings clearly and forthrightly" was an essential element in this teaching. He never lost his desire to know, and he was indomitable in overcoming ignorance.

John Elliot Wills

John Elliot Wills, professor of agricultural economics, University of Illinois, died October 13, 1974. He is survived by his wife, George Ann, Urbana, Illinois; a son, Dr. John E. Wills, Jr., University of Southern California; and two sisters. He retired in 1970 climaxing a forty-five-year career in agriculture exemplifying both the spirit and the functions of the land grant system of research and education. The distinction of his career rests in the breadth and quality of his accomplishments in classroom teaching, extension, research, and administration.

He was born at Watseka, Illinois, received the B.S. degree in agricultural education at the University of Illinois in 1925 and taught vocational agriculture at Monticello, Illinois for five years. This was followed by forty years of service at the University of Illinois and the University of Tennessee. He received the M.S. in farm management at the University of Illinois in 1932. He studied at the University of Chicago and at the University of California-Berkeley and received the Ph.D. in economics in 1937.

During most of his professional career, he was actively involved in teaching courses in farm management and in advising students. He developed and taught a new course in farm operations. Wills was well known for the personal interest he took in each student, especially students from other countries. This is reflected in establishment of the John E. Wills Emergency Loan Fund for foreign students at the University of Illinois.

His research centered on means for attaining efficiency of farm use of labor and machinery. Several bulletins and journal articles resulted. His special work in farm adjustment problems is recorded in the book, *Southern Illinois*, of which he was a contributing author.

Wills' extension contributions included programs

to establish test-demonstration farms in southern Illinois to emphasize better family living and efficiency in labor and power use.

Early in his career, Wills's talents in working with people and organizations were recognized. From 1939 to 1942 he was Tennessee State director of the Bureau of Agricultural Economics, U.S. Department of Agriculture, with responsibilities to coordinate all agricultural state and federal agencies. At the University of Illinois he participated in and supported administrative efforts in many ways. In addition to serving as coordinator of extension work in agricultural economics, he acted as head of the Department of Agricultural Economics on numerous occasions. His contributions were particularly effective on many departmental, college, and university committees. He played a key role in formulation of policy with respect to the Illinois Farm Business Farm Management Association.

Wills will be remembered by his professional colleagues and friends for his extraordinary personal traits. He was scholarly yet pragmatic; humble, unassuming, and willing to listen but, upon weighing the many aspects of a problem situation, confident and willing to decide and act. Qualities such as these made him effective in attaining the complementarities among teaching, extension education, and research and in bringing together diverse talents and interests in committee work and in administration. He was active in agricultural professional and honorary societies, rarely missing an annual meeting of the American Agricultural Economics Association.

ECONOMIC INQUIRY

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OTHER CONTRIBUTIONS by .... William Poole, Michael R. Darby, D. T. Scheffman, William Patton Culbertson, Jr. and Donald E. Wise

Edited by Robert W. Clower
Department of Economics, University of California, Los Angeles

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CANADIAN JOURNAL OF AGRICULTURAL ECONOMICS

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Land Valuation for Tax Assessment and Land Use Planning—The Search for and Use of Appropriate Measures .... *W. van Vuuren*

Price Stabilization Through Deficiency Payments .... *George Kennedy and Wilfred Candler*

Cattle Feeding Economies of Size Revisited .... *Joseph C. Meisner and V. James Rhodes*

Resource Allocation in Agricultural Research Using Socio-Economic Evaluation and Mathematical Models .... *D. G. Russell*

Note

The Use of Zero Constraints in Polynomial Distributed Lags .... *Karl D. Meilke*

Book Review

Published by The Canadian Agricultural Economics Society
Editors: W. E. Phillips and M. M. Veeman
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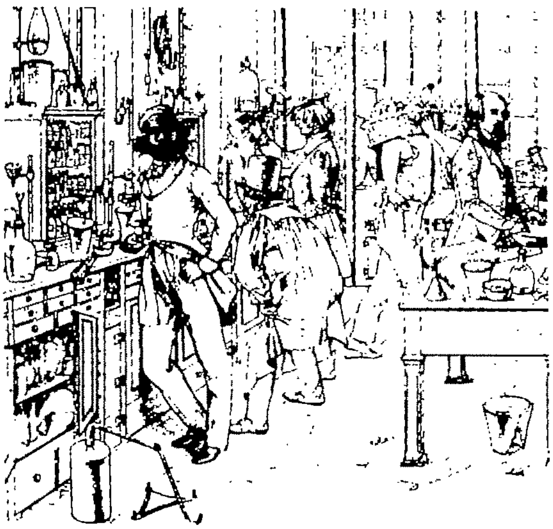

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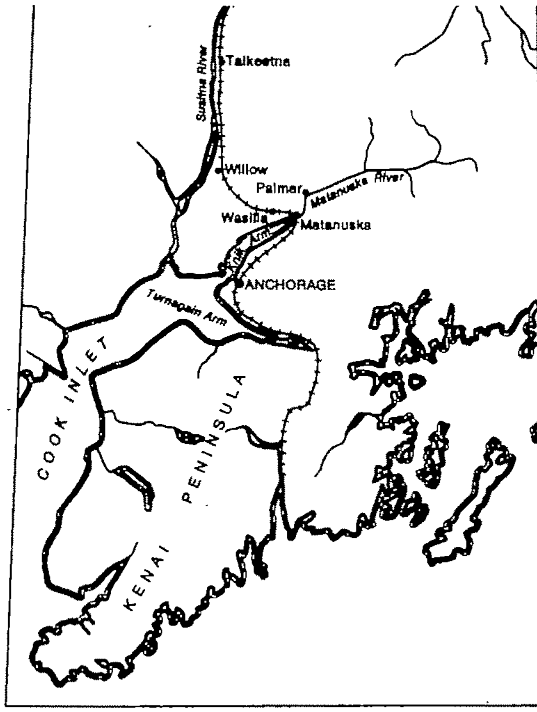

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CONTENTS: Introduction; I: The Case for the Sub-system; II: Sub-systems simply explained; III: Productivity measures in the context of the Sub-system; IV: Application of Macro-economic analysis to sub-systems; V: Extensions of such applications; VI: The Agricultural Sub-system's Past & Future Technical Progress; VII: Conclusions. *Appendices:* A,B: Mathematical Proofs and Addenda; C: Data; D: Dovring Indices; E: Agricultural Index Numbers; F: Input-Output Concordance Tables; G: Employment and Capital Components for the Agricultural Sub-system. Bibliography.

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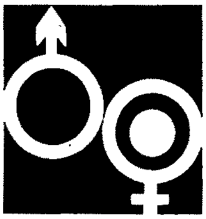

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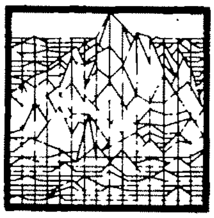

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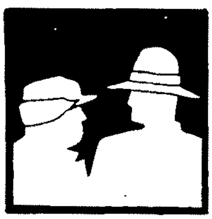

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—sponsoring annual awards for outstanding extension programs, distinguished teaching, and outstanding research;
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American Journal of Agricultural Economics

Volume 57 Number 5
December 1975 Proceedings Issue

In this issue: Proceedings from the annual meeting of the American Agricultural Economics Association held August 10–13, 1975 at Ohio State University, Columbus, Ohio

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Editorial Communications

All manuscripts and editorial correspondence, except that concerning "Books Reviewed" and "Books Received," should be addressed to the editor, William G. Tomek, Department of Agricultural Economics, Cornell University, Ithaca, New York 14853.

Communications concerning books for review and books submitted for announcement in the *Journal* should be sent to the book review editor, Francis E. Walker, Department of Agricultural Economics and Rural Sociology, Ohio State University, Columbus, Ohio 43210.

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Volume 57 Number 5
December 1975 Proceedings Issue

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Geoffrey S. Shepherd
S. V. Ciriacy-Wantrup
Holbrook Working

Geoffrey S. Shepherd

1975 Fellow

Professor, Department of Economics, Iowa State University, 1927–69; professor emeritus, 1969–present.
Principal economist, Commodity Credit Corporation, 1941; division economist, Office of Price Administration, 1945.
Consultant on agricultural price policy, West Germany, 1949; Japan, 1951.
Vice president, American Farm Economic Association, 1951.
Economist and advisor on agricultural price and marketing problems, Burma, 1957–58; Peru, 1965–69; Venezuela, 1970; Indonesia, 1971; Paraguay, 1973–75.

Geoffrey S. Shepherd has achieved an international reputation through his books and articles. In early career he established himself as a leading scholar in each of three major fields: agricultural price analysis, agricultural marketing, and agricultural price policy. His textbooks set high standards for the appropriate use of economic theory and quantitative methods in addition to the technical and institutional knowledge also required in these fields. He was a top contributor to the *Journal of Farm Economics* and was surpassed only by John D. Black in total number of contributions to this journal from 1929 through 1953.

Born in England in 1898, Shepherd moved to Canada with his parents at an early age and grew up on a ranch in Saskatchewan. His education included a B.S. in agriculture at the University of Saskatchewan (1924), an M.S. in agricultural economics at Iowa State College (1925), and a Ph.D. in economics at Harvard (1932). He became an assistant professor at Iowa State College in 1927.

At Iowa State, Shepherd had a distinguished career in teaching and research. More than sixty graduate students completed Ph.D. or M.S. degrees under his supervision. During the 1930s and 1940s Shepherd refused many offers of permanent employment in Washington but did accept short-term assignments at the principal economist level in the Commodity Credit Corporation and the Bureau of Agricultural Economics (where he wrote a major report in 1941 on "Controlling Corn and Hog

Supplies and Prices") and at the chief economist level in the Food Price Division of the Office of Price Administration. In 1949 he responded to an urgent request from West Germany for his advice on the problems of transition from fixed to freer prices, and in 1951 he served as an adviser on price policy to the ministry of agriculture in Japan.

Shepherd is an unusually lucid writer. His textbooks, *Agricultural Price Analysis* (1941) and *Marketing Farm Products* (1946), have been issued in several editions and are still standard works in their fields; together, their cumulative sales have exceeded 50,000 copies and their influence has been worldwide.

Shepherd was vice president of the American Farm Economic Association in 1951. Since the later 1950s he has applied his skills and experience to the agricultural price and marketing problems of several countries—Burma, Peru, Venezuela, Indonesia, and, most recently, Paraguay.

S. V. Ciriacy-Wantrup

1975 Fellow

Professor, Department of Agricultural and Resource Economics and the Giannini Foundation of Agricultural Economics, University of California, Berkeley, 1938–73; professor emeritus, 1973—present.

Assistant to the Chancellor for Research in Resource Planning, University of California, Irvine, 1963.

Commissioner, Governor's Advisory Commission on Marine and Coastal Resources, 1967–73.

Member, Committee on International Marine Science Affairs Policy, National Academy of Sciences-National Research Council, 1969–72.

Member, Marine Advisory Committee, California Department of Fish and Game, 1969–74.

Research marine economist, Institute of Marine Resources, University of California, San Diego, 1970–71.

Fellow, American Association for the Advancement of Science.

Author, *Agrarkrisen und Stockungsspannan zur Frage der langen "Welle" in der wirtschaftlichen Entwicklung,* 1936; *Major Economic Forces Affecting Agriculture,* 1947; *Resource and Conservation: Economics and Policies,* 1952.

S. V. Ciriacy-Wantrup's long-standing role as an international leader in the gradual evolution of the field of resource economics began several decades before the current and almost universal recognition of the crucial importance of resource development and conservation in national and international policies. His extensive writings number well over a hundred items. His best known and most influential book, *Resource Conservation: Economics and Policies,* is now in its third edition and has been translated into other languages as well.

Born in Germany, Wantrup attended the University of Berlin, the University of Vienna, and the University of Bonn. He earned his M.S. at the University of Illinois under an international exchange program and received a Dr. Agr. degree from the University of Bonn. Concerned with the loss of academic freedom under Nazi rule, he left the staff of the University of Bonn and emigrated to the United States.

After a brief stint with the Rockefeller Foundation, he joined the Giannini Foundation of Agricultural Economics and the Department of Agricultural Economics at the University of California. Although resident on the Berkeley campus since 1938, Wantrup has had considerable influence on other campuses of the University of California system, serving as research marine economist, Institute of Marine Resources at San Diego, and assistant to the Chancellor for Research in Resource Planning at Irvine.

His vast knowledge and expertise in re-

source economics have been recognized by many prestigious institutions, including governmental units in most of the countries of Europe. He has been a Fellow of the American Association for the Advancement of Science, has twice received Guggenheim Awards, and was a resident at the Institute of Advanced Studies at Princeton and a Fellow of the Rockerfeller Foundation. He served on the International Marine Science Affairs Panel, Committee on Oceanography of the National Academy of Sciences—National Research Council.

Wantrup has also been noted for his skill as a teacher, particularly at the graduate level. As many as five students have completed their Ph.D. programs under his supervision in a single year. Since 1973, when he became professor emeritus, six additional students have completed their programs under his guidance. He has held visiting professorships at several universities.

His impact on the profession must be measured not only by his published research but also by the large number of his disciples in every level of academic as well as governmental activity.

Holbrook Working

1975 Fellow

Research associate, Food Research Institute, Stanford University, 1925–38; professor, 1938–52; associate director, 1952–60; professor emeritus, 1961–present.
Assistant and associate professor, Department of Agricultural Economics, University of Minnesota, 1920–25.
Chief statistical consultant, War Production Board, 1943–44.
Founding member, Econometric Society.
Fellow, American Statistical Association.
Fellow, American Association for the Advancement of Science.
Author, "The Statistical Determination of Demand Curves," *The Quarterly Journal of Economics,* 1925; "The Theory of the Price of Storage," *American Economic Review,* 1949; "A Theory of Anticipatory Prices," *American Economic Review,* 1958.

For more than fifty years, Holbrook Working has pioneered the use of quantitative techniques in the analysis of commodity price movements. A founding member of the Econometric Society, he was one of the first economists to use multiple regression techniques on important agricultural problems. In later years, his path-breaking articles on anticipatory prices and the price of storage helped the entire profession to understand the theoretical and empirical foundations of commodity futures markets.

Working was born in Colorado in 1895. He received his M.A. from Cornell University and his Ph.D. in agricultural economics from the University of Wisconsin. Following five years on the faculty of the University of Minnesota, he joined Stanford University's Food Research Institute in 1925. In September 1975, on the fiftieth anniversary of his coming to Stanford, a newly endowed chair will be named in his honor.

Working's first article, published in 1922, dealt with a quantitative analysis of factors affecting the price of potatoes in Minnesota. His most recent essay, written in 1975, involves a new interpretation of the relationship between futures and cash prices for beef cattle. In the interim, he made important research contributions in several areas. In the 1920s and 1930s he authored and coauthored more than twenty articles on the world wheat economy. His most important statistical contributions involved techniques in de-

mand, forecasting, and random-walk analyses. Working's greatest contribution to the profession, however, was a series of articles on commodity futures markets. Monographs in 1933 and 1934 on price relationships between new and old crop wheat futures foreshadowed his theories of the price of storage and inverse carring charges fifteen years later. These essays in turn were a major breakthrough in economic understanding and made possible in 1953 his complete revision of the theory of hedging. He thus established commodity futures markets as a specialized area of study and his students have built on the foundations Working laid to achieve notable extensions of knowledge.

Working's service contributions have been equally impressive. He has been an active leader in several professional organizations and a former director of the Social Science Research Council. As a consultant to the U.S. Department of Agriculture, he played an important role in the improvement of the statistical base for agriculture. In his capacity as chief statistical consultant to the War Production Board in 1943–44, he helped apply new statistical techniques to questions of quality control.

Now a vigorous 80, Holbrook Working continues to combine his long-standing professional and personal interests. He can be found almost daily in his office, extending theories of futures markets or actively planning a new excursion into the Sierras.

Presidents, 1910–76

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James T. Bonnen

1975–76 President

Professor, Department of Agricultural Economics, Michigan State University, 1954–present.
American Farm Economic Association award for outstanding Ph.D. thesis, 1957.
Senior staff economist, President's Council of Economic Advisors, 1963–65.
Award for the outstanding article published in the *Journal of Farm Economics,* 1965.
Member, President's National Advisory Commission on Rural Poverty, 1966–67.
Distinguished Faculty Award, Michigan State University, 1972.

James T. Bonnen was born in South Dakota in 1926. Most of his early years were spent in the community of College Station, Texas where his father, C. A. Bonnen, served as a professor of agricultural economics on the faculty of Texas A&M University.

In 1948 he was awarded a B.A. degree in economics by Texas A&M University. He began his graduate study and earned an M.A. from Duke University and a Ph.D. from Harvard University, where his work with John D. Black led to his interest in institutional and organizational problems facing American agriculture.

Bonnen joined the faculty of the Department of Agricultural Economics at Michigan State University in 1954 and subsequently rose to the rank of professor. Within the department he has been an active teacher as well as a productive researcher in agricultural policy. He has served on numerous committees in college and university academic governance. For two years, 1972–74, he chaired the Steering Committee of the Faculty, a committee which is the hub of academic governance and whose members are elected by the faculty to be their chief voice in university governance.

During the period August 1963 to July 1965 he was on a leave of absence from the university to serve on the staff of the President's Council of Economic Advisors. He was on the Presidential Task Force on Agriculture in 1964 and was appointed by President Johnson as a member of the President's National Advisory Commission on Rural Poverty in 1966–67.

Bonnen's major areas of research and publication have been in commercial agricultural policy, especially measurement of excess productive capacity and the distributional consequences of commodity programs; the organization and behavior of agricultural institutions, including the U.S. Department of Agriculture and the land grant colleges; rural poverty; and the social role of U.S. higher education. Most recently he has been working on the problems of the data base for agriculture and rural society decision making.

Bonnen was a member of the American Agricultural Economic Association's Doctoral Thesis Award Committee from 1961 to 1963, chairing the committee in 1963. He also served as chairman of the AAEA Economic Statistics Committee from 1969 to 1974. This committee was instrumental in focusing the attention of the AAEA on the issues which became the theme for the 1975 presidential address.

Bonnen has been an active consultant to industry, government, and foundations. He has served on the National Advisory Committee to the Institute for Research on Poverty, on the editorial board of the *Journal of Social Indicators Research,* and as consultant to the Bureau of the Budget and the Council of Economic Advisors.

Among the awards and honors which have been bestowed on Bonnen are the AAEA award for Outstanding Doctoral Thesis for his thesis entitled "United States Agricultural Capacity: A General Equilibrium Model for 1965" submitted to Harvard University in 1956 and the Award for Outstanding Article in the *Journal of Farm Economics* for his article entitled "Present and Prospective Policy Problems of U.S. Agriculture" published in 1965. In 1972 Michigan State University presented him its Distinguished Faculty Award, the highest award the university makes to a faculty member.

Bonnen is also active in the community in which he lives and works. He, his wife Sarah, and their five children reside in East Lansing.

General Sessions

Improving Information on Agriculture and Rural Life

James T. Bonnen

It is a capital mistake to theorize before one has data.
Sir Arthur Conan Doyle (P. 163)

The discovery of facts . . . depends at least in part on concepts, assumptions, and inferences which can only be defended with reference to normative presumptions.
Marc J. Roberts (P. 54)

If there is no 'given' in experience, then there is no difference between deduction and induction.
C. W. Churchman (P. 145)

I should like to share with you a growing problem in the information base from which this profession works. Over the past five years it has become for me an absorbing challenge and a learning process that in many ways is only just begun. It is an experience which has already been rich in intellectual excitement and filled with implications for the future growth and social usefulness of agricultural economics.

What follows evolved out of my experience of having chaired the American Agricultural Economic Association's Committee on Economic Statistics, which was organized in 1970 and which was asked to examine the growing claims that various agricultural data were deteriorating. We found that certain of the older food and fiber statistics were indeed performing less well in some longtime repeated uses (AAEA). However, we also found that the statistician, at whose door the complaints were usually placed, was not responsible for this situation so much as was the agricultural economist. This follows from our discovery that it is not in measurement of data where we were failing but in the adequacy of the concepts underlying the data.

I want to explore the meaning of this and related discoveries for the individual agricultural economist as well as the profession. I shall argue that the problems of agriculture and of rural society, indeed, societal problems generally, are best understood as fundamentally problems of information processing. Thus, if we agricultural economists wish to solve problems in the society, we must first solve the implicit information system problem. To the extent that agricultural economics is able to master the information problems within its purview, it establishes its analytical capacity and its social usefulness. Successful information processing is in turn primarily a problem of the appropriate design of the information systems within which data are collected, analyzed, and acted upon by decision makers.

I will first comment briefly on the current state of our data base and analytical capability in contending with the problems we face in agriculture and rural society. Secondly, I want to present what I believe is the most useful way of defining and viewing the nature of data and its relationship to analysis and to information. This paradigm of an information system expands one's understanding of the problems agricultural economics faces as a profession and suggests some characteristics which must be recognized in the design of any improved data collection and analysis process. Third, I will briefly describe some exciting parallel developments which come to similar conclusions and provide important further insights into the design of information systems and, thus, our capability of managing the problems of a rapidly changing world. Finally, I will comment on the implications of this for professional agricultural economists.

Presidential address.

James T. Bonnen is a professor of agricultural economics at Michigan State University.

This address was abridged for oral presentation. The author is indebted to the faculties at Purdue, Clemson, and the University of Illinois, where he presented seminars on this topic. He also profited from an informal weekly seminar on information systems during the spring term at Michigan State University with Alan Baquet, Tim Baker, Bo Andersson, and Glenn Johnson. An early version of this presentation was reviewed by more of his colleagues at Michigan State University than can be listed. He is especially indebted to Peter Asquith, C. B. Baker, L. V. Manderscheid, Harry Trelogan, and Jim Hildreth. Any errors, of course, are the author's.

Observations on the Current State of Our Information Systems

The AAEA Economic Statistics Committee concluded that in those instances where long-collected agricultural data were not performing as well as they had in earlier years, the problem most frequently was a growing obsolescence in the concepts which the data system attempted to measure. Some of these concepts, such as the idea of a farm, are so old and so much a part of our historical tradition that we hardly think of them as concepts at all. But the "family farm," with all its value and organizational assumptions, constitutes the central concept around which three-quarters of our food and fiber statistics are designed and collected. Yet it has become an increasingly obsolete representation of the reality of the food and fiber sector. The concept is more than fifty years old, and the structure of the food and fiber industry today only vaguely resembles the structure that prevailed at the time the concept was created. The world has changed and the concept has not.[1]

Conceptual Obsolescence

Some agricultural data are more accurate today than before. Most of these data are based on concepts that are biological or physical and have not changed or have changed little. Examples would be the number of cattle and pigs and the acreage and pounds of potatoes or cotton produced. The great improvement in accounting, measurement, and data-processing capability over the last thirty years has combined with conceptual stability to increase the quality of some data. Thus, crop and livestock production estimates, with their biological and physical concept base, tend to be far better statistics today than they were fifty or even ten years ago, despite the criticism they receive.

Even certain statistics based on social science concepts have retained most of their reliability and in some cases have actually been improved. This tends to be the case for those food and fiber statistics where technological and organizational changes have not been rapid. For example, measures of farm production and yields of wheat and most cereals appear to have lost relatively little in conceptual reliability while gaining much in reliability of measurement. Grain prices are another matter. At the other end of the spectrum, where change in the food and fiber sector has been most extreme, statistics on farmgate broiler production are weak and broiler prices have become nearly impossible to collect or interpret. In poultry and eggs and in many fruit and vegetable products, contracting and vertical integration of both inputs and outputs have undermined, if not destroyed, the traditional concept of the farm which underlies production and marketing statistics. Even the discovery of beef prices has grown more difficult and the data ambiguous. Data on other livestock, cotton, tobacco, peanuts, and other commodities fall in between these two extremes.

Conceptual obsolescence in data is of two types. It can occur not only because of changes in the organization and nature of the food and fiber industry, as I have just described, but also because the agenda of food and fiber policy (public and private) shifts drastically, as it has recently, changing the questions which the information system is expected to answer. When the questions change, it will almost always be found that the conceptual base of some data, especially secondary data, is not a fully appropriate representation and also that some data critical to the new questions are not even being collected. When normative or positive change occurs either in the object being represented by data or in the environment of the object, conceptual obsolescence is almost certain to follow.

Recent major examples of conceptual obsolescence of data arising from changes in the environment of agriculture can be seen in the entirely new questions which agricultural economists are asked to answer today, as a consequence of new values held and new positive knowledge about the environment, the energy economy, and the world food situation. The overall agenda of urgent agricultural policy issues has changed almost completely since the Depression when the better part of our present data system was designed and built. While some older data have been conceptually redesigned to respond to new questions, by and large we have "made do," fiddling with different definitions of the same concept. Thus, for example, the farm has been redefined in almost all recent agricultural cen-

[1] Conceptual obsolescence is not limited to agricultural statistics. All of our older social and economic statistics share in this problem. It is also obviously a difficulty that will continue to plague all data systems involving social and economic behavior where change is rapid in a modern society.

suses, while the concept itself has slowly become so obsolete that no matter how sensible the new definition, we still measure something that in some major degree no longer exists.

Farm income is a prime example of both types of conceptual obsolescence. While some improvements have been made, the concept still fails to net out certain expenses and assets and misses some income flows entirely. The design of the farm income concept is still distorted by the political imperative of the parity income calculation and is grossly inconsistent with the conceptual design of national income accounting (AAEA). These are not easy problems to resolve. Eldon Weeks and his associates in the Economic Research Service (ERS) have examined the major deficiencies in the design of farm income numbers and have proposed some original and practical solutions for certain of these deficiencies (Weeks; Weeks, Schluter, and Southard; Carlin and Handy; Carlin and Smith; Simunek).

One might ask what difference it makes whether one does anything about any of these problems. Even the most casual look through the recent Report of the Task Force on Farm Income Estimates should give pause to any user of farm income numbers (Hildreth). It was estimated recently that improving the measurement and moving the beef and dairy cattle inventory changes from current income (where most of it is now accounted for) to a capital account (where it should be) would have had the effect of subracting about $7.5 billion from 1973 net farm income of $32 billion (Dyer). Hardly a minor impact!

Both farm input and output measures have long exhibited many conceptual deficiencies, even though some improvements have periodically been made. As the American farm industrialized, specialization has separated many production, processing, and marketing functions from the farm to agricultural business firms. As a consequence, agriculture long ago ceased to be just farms. While some of our colleagues are at work on it, we still lack an adequate paradigm with which to describe and categorize the structure of a modern food and fiber industry and provide a general conceptual basis for sector statistics. There is, for example, no accurate basis for describing the character and for measuring the size or productivity of the sector or its social performance.

In the case of social and economic statistics for rural society, the overpowering problem, as the AAEA Economic Statistics Committee pointed out, is the lack of data. This often is because there has been no demand to finance their collection. But even in areas of increasing public concern, as in rural development and in the various dimensions of human welfare, little coherent data and few well-developed information systems exist. The primary reason is found in the absence of any coherent conceptual or theoretical base for either data collection or analysis. Economists cannot even define adequately what is meant by economic or rural development.

Institutional Obsolescence

Rapid or steady long-term technological, organizational, and associated value changes not only create obsolescence and mismatching in the conceptual base but also in the institutional structure of statistical systems. This is often compounded by the reorganization or development of new administrative structures without adequate care for the integrity or capability of involved data systems. Changes in basic statistical measurement techniques (e.g., shifting the agricultural census from a complete enumeration to list frame surveys) which are unmatched by an implementing organizational adjustment also can creat another form of institutional obsolescence and inefficiency (American Agribusiness Associates). As a result of institutional obsolescence or reorganization, current administrative structures often do not bring the necessary information together at the time and places in the structure where it is most needed by decision makers.

Empiric Failure in Design and Collection of Data

Let me turn to a different though related problem: the increasing tendency of economists to propagate endless theories, concepts, and models of unknown value because they fail to design and collect data for an adequate empirical test. In his 1970 presidential address to the American Economic Association, Harvard professor and Nobel Laureate Wassily Leontief indicted economists for this failing. Leontief faults economists for being satisfied with secondary data which does not match and thus cannot adequately test their theoretical concepts. His point is that theory will never be improved without empirical test, and in its absence, economists are playing sterile games.

Variations on Leontief's criticism have been voiced in many presidential addresses of economists (Bergmann, Blackman, Hahn, Phelps Brown, Maisel, Worswick). In one of the most recent, Bergmann has argued that it is worse than Leontief imagines since "these days the best economists don't even look at secondhand data; they get them on magnetic tape and let the computer look at them. Economists have voluntarily set for themselves the limits on data collection faced by students of ancient history" (p. 7). In the Richard T. Ely lecture, Alice Rivlin of Brookings lamented that "disdain for data collection is built into the value and reward structure of our discipline. Ingenious efforts to tease bits of information from unsuitable data are much applauded; designing instruments for collecting more appropriate information is generally considered hack work" (p. 4).

Leontief pays a high compliment to this profession by explicitly exempting agricultural economics from his indictment. He describes our discipline as "an exceptional example of a healthy balance between theoretical and empirical analysis and of the readiness of professional economists to cooperate with experts in the neighboring disciplines . . . " (p. 5). However, the AAEA Economic Statistics Committee argued in 1972 that the honor Leontief accords us "properly belongs to an earlier generation . . . " (p. 867) and that agricultural economists are now falling into the same errors which Leontief ascribes to the economics profession.

The capacity and reputation of agricultural economics was built around a balanced investment in the theoretical and empirical. We have lost much of our early interest in the design and collection of data and now often fail to collect needed data or to respect those who do. There is evidence that we are failing also to update our conceptual base at a pace sufficient to keep up with major changes in agriculture. Conceptual failure directly undermines the deductive processes of knowing, while empirical failure directly undermines the inductive processes of knowing. Thus, these are two different kinds of failure. Either long pursued could be fatal. I am sure we will not let this happen.

Property Rights and Vested Interests in Data

Some data problems arise because information always involves property rights, some of which are privately held. As we attempt to redesign or create new data responding to the public interest in problems of international trade with the Soviet Union or China or in public policy issues involving the behavior and performance of the food and fiber sector, we find absolutely essential information is often held by a few firms whose immediate interests are often not served by releasing that information. As industrial concentration continues to grow in food and fiber markets, the issue of private ownership of information versus the public's right to know will become more and more critical and heated. Giant firms acquire with their great size not only an impact on markets but a major responsibility for public information. Where the data on a market are collected from and distributed to firms by a trade association, the tendency to monopolize data is even greater (Stigler, p. 220).

Similarly, bureaucracies and various user groups develop substantial vested interests in existing concepts and measurement procedures. Thus, they behave as if they had a property right in certain data or data systems and often politically are able to enforce their interests. Any change in the design of data must face this problem as a cost of replacing an old statistic with newly designed data. Arrow rightly characterizes this problem as one of human capital made obsolete by change (pp. 40–41).

The Economics of Information

My objective here precludes an adequate discussion of the complex and important problems of the economics of information. But it is worth noting that the further an economy departs from the assumptions of the Neoclassical model (where information is a free good), and the greater the level of uncertainty (up to a limit), the higher will be the value of information. Appropriately designed information allows one to reduce uncertainty and to manage its undesired consequences. But uncertainty is inherent in the human condition. While "sufficient expenditure" on information will keep the effects of uncertainty "upon people . . . within tolerable or even comfortable bounds, . . . it would be wholly uneconomic to eliminate all its effects" (Stigler, p. 224).

American food and fiber production has in recent years been released from the protective custody of U.S. farm program controls into an internationally interdependent market and an

accompanying sea of uncertainty. The value of information has increased many times over, thus exposing more clearly the many weaknesses in information sytems. During the past several decades of shelter from market uncertainty, the major agricultural information systems constructed during and just after the Depression were so undervalued that they have been allowed to decay seriously. Improvements are traceable primarily to remedial action following various policy failures and to a few examples of outstanding individual leadership.

Information is an expensive commodity as well as being valuable. Returns to careful decisions about data and information are high. The cost of poor decisions and subsequent lack of appropriate information is extremely high (Bonnen 1973). The foundation of effective information management is careful design of data and information.

Data, Analysis, and Information: A Paradigm

One of the first problems encountered by the AAEA Economic Statistics Committee was a confused but common vocabulary which erroneously equates data with information and fails to distinguish the distinctive steps in the process by which data and information are produced. We also seem to lack a clear understanding of how the analytical process or system of inquiry over which the agricultural economist presides relates to data collection and to the information system. Let me share with you a paradigm or useful way of viewing an information system which was developed out of a struggle with these questions.

The Nature of Data and a Data System

Every data system involves an attempt to represent reality by describing empirical phenomena in some system of categories, usually in quantified form. Data are the result of measurement or counting, but when one sets out to quantify anything, the first question that must be answered is, "What is to be counted or measured?"[2] If the configuration of data produced is to be internally consistent and have some correspondence with reality, the ideas quantified must bear a meaningful relationship to each other and to the reality of the world being described. In other words, there must be some concept of the reality of the world that is to be measured. Reality is nearly infinite in its variation and configuration and must be simplified or categorized if man's mind is to handle it in a systematic way. Thus, in producing accurate data, one either implicitly or explicitly develops a set of concepts which in some significant degree is capable of portraying and reducing the nearly infinite complexity of the real world in a manner that can be grasped by the human mind. Data are a symbolic representation of those concepts. If the concepts are not reasonably accurate reflections of that real world, then no amount of sophisticated statistical technique or dollars invested in data will produce useful numbers (see data system components in fig. 1).

While data presuppose a concept, concepts cannot be measured directly (or in a strictly logical sense measured at all). Rather, we operationalize the concepts by establishing (defining) categories of empirical phenomena (variables) which are as highly correlated as possible with the reality of the object of our inquiry.

Thus, there are three distinct steps which must be taken before one can produce data which purport to represent any reality. These are conceptualization, operationalization of concept (definition of empirical variables), and measurement. This is what I understand a data system to be (see fig. 1).

The failures and limitations of any one of these data system components constrain and limit the quality and characteristics of the data produced. An inadequacy at any stage can be offset only to a very limited extent by improvements or manipulations at the other stages. Thus, the great improvements in statistical methodology and data-processing techniques over the last generation cannot offset failures at the conceptual level, for no matter how well one manipulates the numbers, one may still be measuring the wrong thing. For example, the parity price concept, no matter how well measured, is a poor representation today of farmer welfare. The "cost of production" concept central to the operation of the Agriculture Act of 1973 is so inadequate as a representation of the complexities of farm cost structures that no amount of genius in operationalizing or

[2] Data, strictly speaking, are not limited to quantified forms, but this discussion will be confined to statistical data. Implicit in the question of "what is to be measured" is also the question of "why."

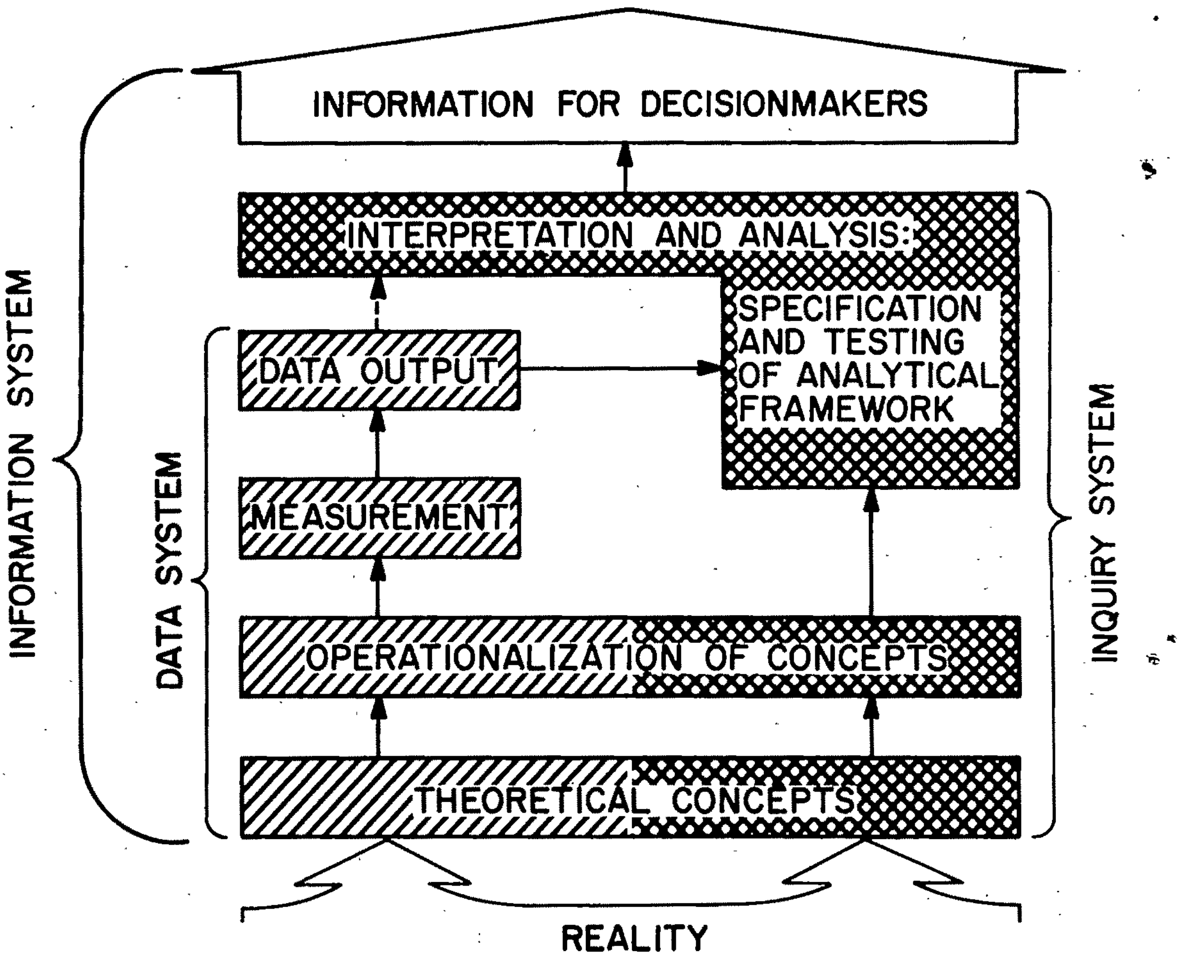

Figure 1. An agricultural information system

measuring it can redeem its inadequacy as a concept.

It is worth noting that the term reliability of data has three different possible meanings in this paradigm: reliability of measurement, which is the way the statistician normally uses the term, reliability of operationalization, and conceptual reliability.

The Nature of Information

Data are not information (Eisgruber, Dunn). An information system includes not only the production of data but also analysis and interpretation of these data in some purposeful policy decision or problem solution context. The demand for data is generated by the need to make decisions on problems, but decision makers rarely use raw data. Rather, there are intervening acts of interpretation, through statistical and economic analysis, policy staff and political evaluation, etc., which transform data into information by placing them in a specific problem context to give the data meaning and form for a particular decision maker (see fig. 1). Symbolic data acquire most of their "meaning" and value from the context and design of the information system in which they appear. Thus, I understand an information system to include not only a data system but the analytical and other capabilities necessary to interpret data.

Analysis as a Function of Information

What does the agricultural economist do when he plays the role of analyst? In our training we all acquired much the same epistemological sense of how to analyze and solve problems; that is, there is a base of theoretical concepts, a body of theory purporting to represent reality which we operationalize through definition of various variables, often specified formally in a model which must be matched with data

or measured representations of these same variables. The model or analytical framework is then tested against the data and conclusions drawn. Thus, in these three steps in analysis, we find two of the same components observed in a data system: theoretical concepts and operationalization of those concepts.

Thus, in data systems (left side of fig. 1) and in analytical systems of inquiry (right side of fig. 1), we are operating from the same set of theoretical concepts and, ideally, the same set of definitions which operationalize those concepts. Unless economic theory and economic statistics meet on a common conceptual ground, there can be no mesh between empirical analysis and theory.

The agricultural economist is clearly responsible not only for the design and maintenance of the profession's analytical framework but also for the design of the conceptual base of the data systems which provide the empirical content for that analysis. The commonplace notion held by economists that statisticians alone are responsible for the design and production of data is a grave distortion of our professional responsibilities (Bonnen 1974). It not only reflects an epistemological weakness but also a lack of understanding of the historical development of data systems. From earliest times data systems have been conceived to solve problems, and professionals whose knowledge was relevant to the problem were involved in design of the data system.

Let me state clearly the implications of this paradigm. (*a*) Data are not information. They are symbolic *objects*. Information is a *process* which imposes form and gives meaning. Data acquire meaning only in the problem context of some information process.

(*b*) All information systems have a purpose because they are subsets or components of social systems which are designed for some problem-solving purpose. Thus, data collection and analysis always has a purpose and can only be understood fully in a social system context.

(*c*) Data collected for societal decision making must have a social theory base. No matter how ad hoc the collection of data may seem, every measurement act is guided explicitly or implicitly by conceptual and value structures which exist prior to the act of measurement. Data and information are never value free or theory free. Conversely, all concepts or theories have an explicit or experiential prior empirical basis. Theory and data are epistemologically interdependent.

(*d*) Thus, you do not know anything until, as a necessary condition, a deductive, analytic mode of inquiry (see right side of fig. 1) is combined with an inductive, empirical mode of inquiry (see left side of fig.1). What is known from such a process grows in extent and reliability by a repetition of interaction between the deductive and the inductive modes, in which both the analytical and empirical contents of the process are reformulated and improved on the basis of what is learned from each prior iteration.

(*e*) An analytical hypothesis or model and the data for its empirical test must have the same conceptual and definitional base. This is perhaps too logical and obvious to mention, yet a failure to appreciate this fact lies at the heart of our apparent inability to understand and deal with the problem of the accuracy of information provided in agricultural economics. It also lies at the heart of the progressive deterioration in the economists' sense of professional responsibility for the design of the data which they use.

Thus, these last three points are implicit in Loentief's insistence on the necessity for empirical testing of all theoretical formulations with data which are designed around the proper concepts. They are also implicit in the AAEA Economic Statistics Committee's insistence that accurate and useful data can be collected only in a conceptual frame which is an accurate representation of the reality which the data attempt to reflect.

(*f*) Data are symbolic of some phenomena which they are designed to represent. The quality of that representation is only as good as the adequacy of the conceptual base or its operationalization or its measurement.

(*g*) When the phenomenon that is being represented changes rapidly, as it has in the food and fiber industry, the conceptual base of the information system must be redesigned frequently to keep up with the change in the reality being represented and the problems being studied. If the rate of change is high enough, the need for conceptual redesign becomes nearly continuous. This is the fundamental problem in the design of information for agriculture. Failure to keep up with the changes in problems and in reality leads to significant conceptual obsolescence, and the system begins to lose its capacity as an accurate guide for problem identification and solu-

tion or management. This paradigm of the constituent processes of an information system provides a conceptual template with institutional analogues for the design of data and information systems.

Social Change and the Design of Information Systems

The first of several parallel developments are found in the work of Edgar S. Dunn, Jr., who in mid-1974 published a book entitled *Social Information Processing and Statistical Systems: Change and Reform*. This is an exciting and stimulating volume. Anyone starting to examine problems of the design of data or information systems should begin with Dunn. For years Dunn has been involved in the management or study of the problems of statistical and analytical systems. Dunn's ideas and those of the Economic Statistics Committee were both well developed by the time we encountered each other in late 1971 and 1972. We were both struck by the similarity of a number of our ideas, though Dunn was reasoning at a far more general level of information system theory and his ideas were more highly developed. He reinforced and encouraged the committee in its convictions and contributed many stimulating new ideas. Let me point to three ideas out of a dozen exciting insights in Dunn.

We all understand that industrialization and development increases the demand for information. Development leads to specialization of function and organization. This greatly increases the need for coordination and, thus, the social returns to and the demand for information. However, it also brings about a change in the kind of information demanded, which agricultural economists are failing to recognize in dealing with the design of information systems.

The earliest U.S. data systems were usually built around administrative and management needs. The data required can be described as primarily static and descriptive in nature and involving clear, relatively fixed goals and simple or low levels of information processing.

As society has grown more complex and specialized, the demands are not just for more data and greater accuracy in the articulation of detail. Increasingly the demand is for data in a "learning or developmental mode" (Dunn, pp. 32–33), in which the goals of decision making are not completely specified, and one purpose of an information system is to assist the decision maker in specifying the goals in a progressively more complete form. In a developmental mode, goals and problems may continue to change as learning takes place and thus may never be completely specified. It is obvious that one is not well served in this situation by data which are basically static.

Secondly, in the learning or developmental mode, the information system which perceives and acts on data is itself changing in structure and behavior in response to the information input. Thus, the information system must be capable of perceiving changes not only in the environment but in itself, even under conditions in which such changes themselves become goals (Dunn, pp. 77–85).

As if this were not demanding enough, when the reality of the world, as in agriculture, continues changing rapidly, the need to redesign the system eventually becomes continuous, and it follows that the capacity for redesign must be a normal function of the information system. If the designer does not become part of the system in this situation, the system's capacity to produce useful information will deteriorate.

Another very significant observation can be made about the design of information systems. Any system designed to solve problems will inevitably combine and use different fields of knowledge. Therefore, the concepts underlying the information system will be derived from different disciplines. Agricultural information systems are an excellent example. If such a system is to produce useful data and, in the process, manage its own continuing redesign, a general "theory of social information processing" or, if you prefer, a theory of theories or a "metatheory" is needed. In other words, a means must exist for synthesizing concepts from different bodies of knowledge into a meaningful relationship to each other (Dunn, p. 22).

A metatheory for information system design may well be an impossible goal, but the logic of its necessity is valid and has the virtue of keeping in front of us as designers of information the true complexity of the task. The design of data and information systems is not a job we can assign to any but the best minds.

It is quite clear that the more difficult and abstract system design problems are central concerns of the philosophy of science and, ultimately, are epistemological in nature. In

this literature there is a piece of work which is startling in its clarity of insight into the problems of the design of information systems. Even more remarkable, from an entirely different vantage point or literature, it comes to many of the same conclusions as Dunn. It also reinforces the logic of, and provides further insights into, the information system paradigm presented in this paper. The work is C. W. Churchman's volume, *The Design of Inquiring Systems*. It is not possible here to explore his complex insights adequately, but I can promise anyone who examines Churchman's book a stimulating experience.

It is quite clear that in accommodating or attempting to resolve most of society's problems, social systems are created which are really information-processing devices for managing those problems. While we are keenly aware of our difficulties in society, we seem almost completely unaware that at the base of these problems are a set of information-processing problems that must be dealt with before the urgent needs of society can be served. Much of the difficulty in dealing with these problems arises from our lack of understanding of the information problem. In turn, behind the information-processing problem lies the equally unperceived problem of the design of information systems. It is also quite clear to me that despite conventional wisdom, the most important information problems cannot be seen as merely a matter of inadequate measurement techniques. The inadequacy lies in the design and conceptual base of the information-processing structures that form our social systems.

I am certain much of my difficulty and slowness in beginning to comprehend this problem can be traced to an inadequate understanding of the methods of social science and their epistemological basis. It is this I believe which lies behind the widespread lack of awareness of the true nature of "the data problem."

In any field at any specific time, one is drilled as a student in a received tradition of scholarship or inquiry which, because it is consensual, remains generally unexamined. Churchman does a great service in forcing much of that unexamined intellectual baggage into a conscious perspective.

I am sure that the striking similarities between the information system paradigm presented here and that of Dunn and Churchman's more sophisticated treatment not only tend to validate my limited insights but suggest a far more generalized framework within which work on the problems of the design of agricultural information systems should proceed. Dunn and Churchman also establish clearly the significance which this task of improving our information systems has for the society and for a profession such as agricultural economics.

Final Remarks and Recommendations

In the period from the turn of the century to World War II, the researcher not only designed the analytical framework but typically designed and collected the data for any test of that framework. Communication distances were limited and methodological perspective easier to maintain. Since World War II, specialization has progressively separated the data collection function from analysis and interpretation, and economists now need to be very much more conscious of the necessity for maintaining a common conceptual base for both data and analysis. In addition, some "specialists" in inductive inquiry need to become more conscious of their dependence on the deductive. Many more of us who "specialize" in deductive inquiry need to become much more conscious of our dependence on the inductive.

Agricultural economists have a tradition of inquiry that prevents innocence of the empirical. Even we, however, are increasingly failing in individual and institutional research to do the hard, unglamorous slogging in data collection that often is the most productive of new knowledge.

The agricultural data base in government agencies, in private firms, and universities, at the state as well as national level, is a capital stock, the scope and quality of which governs and limits our capacity to perform as professionals. We must endeavor to deepen our investment in both conceptual respecification and in empirical measures to evaluate that specification. We must work to assure ourselves that we have an appropriate balance between the theoretical and the empirical.

We can approach this respecification or design problem by attacking at one end through the identification of problems in current data and information systems and at the other end of the information process by identifying more clearly the questions that need answers now or will need answers in the future and working

back toward the specification of data needed to answer such questions. This would in itself be both a useful and no small task, for few if any of us understand our existing data systems as systems. In the process we should learn a great deal from identification of system problems, particularly failures of the current system. It then is only a step to modeling the systems in terms of various assumptions as to organizational structure, environment, objectives, and other dimensions in the process of specifying what data are needed to answer what questions. All of these efforts would help us toward the urgent objective of identification and conscious management of our data systems as systems and as part of a still more comprehensive set of information systems.

I have argued that one of the essential elements of an ideal data system is an internal capability for renewal or redesign of the data system itself. How to construct this critical component is not at all clear. The capacity for renewing any system must involve feedback or learning loops within the information system itself. This suggests that at a minimum any major data system should have a group of professionals working continuously on the conceptual base, definitions, measurement, and quality of data. This might be characterized as a statistical system design and quality control shop. There would have to be a similar organization at the information system level. Such organizations would monitor, stimulate, and perhaps contribute to conceptual development in the disciplines upon which the data and information systems are dependent. Perhaps these same groups could maintain close relationships with the users of their data. They also would provide a place in the system which could be the common ground on which information and data users, statistical methodologists, and disciplinary methodologists met. This is quite critical, since any conceptual deficiency in data also represents a conceptual deficiency for the analytical frames within which the data must be analyzed.

I believe we all need to become more conscious of these problems in all of our data collection and analysis or research. We need to teach research methods at a philosophy of science level of epistemological consciousness.

The AAEA should, I believe, continue to provide a forum for the debate on this problem in its *Journal* and at professional meetings. The AAEA Economic Statistics Committee under Jim Hildreth's chairmanship is already moving on to the study of problems of specific data and analytical systems in agriculture. The committee's proposed list of projects holds great promise.

Despite substantial recent efforts, the U.S. Department of Agriculture still needs to expand greatly its efforts at reexamination and redesign of the various analytical and data collection processes over which it presides. The action agencies of the USDA are so oblivious of the problem, they are part of the problem. The Economic Research Service, on the other hand, has in recent years made an excellent beginning and is now quite conscious of and is working on many of the problems of information and data system design. ERS has given unstinted support to the activities of the AAEA Economic Statistics Committee.

Political decision makers as a general rule, however, distracted by the political pressures of the moment, continue as they have for at least twenty years to be unaware or thoughtless of the problems they create for future policy makers. The costs of failure to invest in redesign of data and analytical capability is imposed on other decision makers and the public of ten and fifteen years later. I understand a political decision maker's reluctance to have to explain the impact of a change in the parity ratio or farm income concept to Jamie Whitten and other congressmen. They have my sympathy, but they must support far more effort in redesigning their information systems or the analytical capacity and adaptability of much of the data base of the USDA will continue to decline. There are some interests in the food and fiber sector that would just as soon see this happen, but farmers, consumers, and the nation would be ill served.

The Statistical Reporting Service is one of the great strengths of the Federal Statistical System and of the USDA. It was the professional statistician, in agriculture and out, who responded with the greatest interest and understanding to the Economic Statistics Committee's 1972 report to the AAEA describing the agricultural data problems. It was Harry Trelogan and his colleagues who realized early that there are fundamental difficulties in our data systems. They were largely responsible for the efforts that led to the creation of the AAEA Economic Statistics Committee.

Many are not aware that Harry Trelogan and a core of fine statistical leadership in SRS began over ten years ago to redesign the data

base for which they are responsible. In the process they transformed an old system into one of the highest capacity, most efficient, and competent statistical agencies in Washington. That is not easy to do in the face of the lack of support for statistical budgets that has historically prevailed in government.

Harry Trelogan is retiring as administrator of SRS. If I may be permitted a personal note, it will not be as much fun fighting the data wars without him. A great teacher is always missed. The qualities of his leadership are rare. From Harry Trelogan I learned what integrity in statistics means and what it costs those who maintain it.

I have tried to share with you my own excitement at the discovery of the real implications of the questions raised about the quality of the data upon which we depend as a profession. The significance of these implications for society and for the capacity and social usefulness of this profession is difficult to exaggerate. I hope you too are a little excited. I hope you are able to see the prospect in which at one and the same time we face a major problem in the redesign of agricultural information systems and share in a great opportunity again to contribute to agriculture and the social sciences in a fundamental way, much as agricultural economists did in the early days of econometrics and, in the late 1920s through 1940, when they developed major information systems to manage and ameliorate the problems of a Depression and a World War. We have but to grasp the opportunity. If you chose to work on these problems, I can assure you of an intellectual challenge as great as any you have experienced.

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Policy Formation and the Economist

J. Carroll Bottum

Running through my presentation are four assumptions or assertions which I believe to be true. First, our founding fathers put a heavy emphasis on education by word and deed. They believed it necessary for the functioning and preservation of the type of society they were forming. Second, the changing structure of our society in recent years has increased the number of decisions made in the public arena relative to the private. Third, while all disciplines of a university may contribute research results necessary to policy formulation, economics is the pivotal discipline. And fourth, because policy decision making is so value laden, it requires a special educational approach.

Back in the late 1920s when I became associated with Purdue University, the average yield of corn in Indiana for the decade of the 1920s was 35½ bushels per acre. This was typical of the Corn Belt. It was just 1½ bushels more than was produced per acre in the decade of the 1870s, fifty years before. Corn was being produced according to conventional knowledge. Then, a stream of technical knowledge was added by the universities, supported by supply organizations, and from this combined stream we have increased yields on the average of 1½ bushels per acre each year.

Today we are making policy decisions at the local, state, and national levels from the stream of conventional knowledge plus a small stream of scientific policy information. Do we not need to enlarge the scientific policy stream just as in the technical areas? In my title I have used "Policy Formation and the Economist," not the agricultural economist. Many of us are economists with an agricultural specialty, but many people in the agricultural economics departments are working on problems broader than and other than agriculture. Therefore, I do not believe we should get trapped by the agricultural economic term. Some departments have already changed their name without materially changing their staffs.

Let us now turn for a moment to what certain distinguished economists and public administrators have said about public policy and the economist. Chester Davis, one of the grand old men of agriculture in the 1930s and 1940s, in summarizing the previous policy work of the economists in the 1940 Department of Agriculture Yearbook suggested that the economist "was strong on analysis and weak on remedy" (p. 312).

James Nielson, in his presidential address to this Association said that "in the past decade, I believe that we have overinvested in the development and refinement of quantitative methods. We have spent too little time and energy on discovering and tackling the emerging economic and social problems that most trouble our society" (p. 869).

Secretary of the Treasury William E. Simon approached the point more subtly when he stated, "I sometimes think that economists use decimal points in their forecasts to prove they have a sense of humor."

James T. Bonnen, who was a director of a public policy study in 1968 for the presidents of the land grant colleges, said at the National Policy Conference in 1970, "I believe the universities have a great potential in public affairs if they will focus on the problems of society" (p. 13).

Richard L. Kohls in speaking before the American Agricultural Economics Association said:

> For some reason research and extension efforts in the public policy arena seemed to have declined sharply in recent years. The major role of both policy research and education is to help clarify the problem issues, develop and evaluate potential alternatives for solving them. Perhaps there were no substantive issues, or the problems themselves were too obscure in the public consciousness to deserve attention . . . .
>
> Frankly, considering the problems that our country seemingly faces in the whole broad range of economic policy, this may be the opportunity for agricultural economics again to lead the way. (Pp. 1010–11)

What these gentlemen are trying to say and what I am trying to say is, let's split some new rails and spend a little less time sandpapering

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Fellow's address.

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the old and we will have a bigger pasture. And, let's put in a gate so some of the other pertinent disciplines can join us in this enlarged pasture.

The Formulation of Policy Research

Most students of decision making have come to agree that if there is more than one choice, and there usually is, the procedure is to identify and delineate the problem, develop the possible solutions, set forth the consequences of each solution, and make the decision. This procedure applies equally well in the public policy decision education area except that the decision is left to the public. In the private decision area, the individual or company makes the decision after perhaps a definite recommendation by the consulting firm. In the private area, the decisions are usually more technical and economically weighted, while in the public area they are more value and goal weighted.

Policy decisions are made today in the public sector without many citizens having the opportunity to go through the decision-making process. They should have an opportunity to have the major public problems clearly identified, their alternatives set forth, and their consequences analyzed from both the short- and long-run standpoint. They also need to know not only the total costs and benefits, but what the public costs and benefits and the private costs and benefits are and upon whom these costs and benefits fall in society. The decision can then be made by the normal political processes.

We need today in our universities more individuals and groups with the ability and the courage to tackle the fundamental issues facing U.S. citizens. We need more Harold Breimyers. We need individuals to develop useful blocks of research which can be fit into the decision-making framework. Then we need individuals who will develop the framework for public decision making including the other necessary blocks of research. In fact, the preferred approach would be to develop the decision-making framework first, but we usually end up with the former approach.

Throughout our universities much of the research has policy implications. Therefore, it cannot be coordinated by one school or department, but rather this information needs at appropriate times to be lifted up by some group in the university and put in a policy-decision-making framework for the public. This group also needs, on a voluntary basis, to encourage research in certain critical areas that appear to be coming to the forefront in public policy.

The citizen not only wants to know the consequences of various solutions on equity and efficiency but also on supply, environment programs, security and freedom, or how much regulation will be involved. This makes it mandatory that the policy analyzed brings in the contributing disciplines.

It also becomes important that we appraise the long-run impacts as well as the short-run. The pollster sends out the questions, "Do the citizens want higher fuel prices?" There comes back a resounding "No." Therefore, most politicians are hesitant about talking about any realistic solutions because they all raise costs to the consumer in some manner. This is when we need a strong educational program to get out the facts and solutions and to say what the politician does not feel he can afford to say.

Some politicians say you're asking too much when you ask us to make the analysis and then to educate the public. Politicians say we are supposed to represent the public. I think they have a point especially in closely contested districts where they cannot afford to be statesmen.

Too much of our policy information is in bits and pieces. It needs to be brought together in a decision-making framework by competent scholars. Policy research has probably overemphasized the short-run equity and efficiency criteria at the expense of other considerations and long-run impacts. As Solzhenitsyn says, "He who draws a conclusion only halfway fails to draw it at all" (p. 219).

When some phase of our economic system in the short- or long-run view is not performing adequately, as viewed by society, we have tended to regulate it or socialize it. Witness the postal system, the railroads, the natural gas companies. Our success record in these areas has been something less than sensational. Now we are discussing further regulating or socializing the eastern railroads because of inadequate service and financial failure. We are discussing socializing the medical system and the oil companies because they are providing inadequate service or because they are making too much money.

Equity is one of the important considerations in regulating or socializing the industry. Regulation may correct equity, but it does not necessarily solve the problem of efficiency, environment, safety or many other issues. The issue is not regulations per se, but rather whether they are oppressive and restrictive on the industry or whether they allow for creativity and competition. We still need policy research even though the audience may change from the people to the central government.

Our challenge, as economists, is to develop alternative institutions which allow the producing segments of the economy to perform reasonably, efficiently, and effectively by society's standards. Economists should also be involved in developing social, welfare, and community institutions which most effectively accomplish society's goals. It is further our responsibility to help people understand the limitations of any system for individuals with widely varying expectations and goals. We have a related problem in this area as expressed by Edith Hamilton when she said, "It is not men's greed, nor their ambition, nor yet their machines; it is not even the removal of their ancient landmarks, that is filling our present world with turmoil and dissention, but our new vision of the individual's claim against the majority claim" (p. 245).

The values of equity, justice, and freedom have always been difficult values for the public policy educator to handle. I have personally been forced to accept certain cornerstones in these areas. First is the free spirit of individuals or their right to reject any policy or religion as long as they accept the consequences of that rejection. Second, in a democratic society the right to dissent must be protected. Third, in a democracy the right of the majority to rule must prevail. Fourth, as Rossiter has said, "Democracy, let us remember, has a fundamental commitment to equality, in the best and more realistic senses of that word: to equality before the law, equality of political voice, equality in constitutional rights, equality of opportunity, and equality of consideration" (p. 74).

But after having said this, I also have to accept that we, as individuals, all have varying productive capabilities and goals as a result of our environment and heredity. Thus, if rewards are based on productivity, we get a wide variation in incomes. We put considerable emphasis in our society on justice and equality. But, if everyone's income is the same, then productivity tends to fall to the level of the least productive. Thereby, everyone has less.

Thus, our continuing problem, as institutions are modified is to find that mix of rewards that keeps production up and also provides some equity in the distribution of income. It is a never ending issue which is intertwined in most of our major policy issues. We must have a reward system if we allow for the free spirit of the individual. It has also seemed to me that there is some relationship between economic freedom and economic creativity. For this reason Joseph Schumpeter's writings have haunted me.

The Universities' Resident Teaching Task

As indicated earlier, the public sector of the economy has grown relative to the private sector. The proportion of jobs in the public administration area has increased. Likewise, the mushrooming of regulations arising in the public sector has multiplied the public issues with which those in the private sector must cope. As a result of these changes in society, two needs have developed in the university teaching area. We need individuals trained in public administration and we need individuals entering the private sector to understand the skills required for public problem solving. These needs are being recognized by the staffs in the different universities as is presently shown by their various attempts to meet them.

Today, graduating engineers, agriculturists, business administrators, and students of other professions need a minor in public policy. These should include a limited series of comprehensive courses involving at least the tools for decision making in public policy, government organization and operation, group dynamics, and social action and public administration. This is not an idle proposal, for the president and provost of Purdue University are now in the process of attempting to establish such a program. They are not alone in their thinking as university administrators.

For this program to be successful, it must be staffed by scholars who understand the real world as well as the theoretical. They must not become involved in the impossibility of determining the theoretical concepts of the good

society, but rather how to have a "better" society as expressed by the goals of the people. I have searched the literature and the world for a definition of the good community. I have always been driven back to the definition that it is what that community wants after the people and leaders of that community have been exposed to what the possibilities of that community are.

In this day of highly specialized training we need a common denominator for all graduates. What is more a common denominator than how they govern themselves? At least the grads would have something more to talk about other than the experiences of their fellow classmates. They might also turn to the university for information in the public policy area as they do now in the technical area.

Adult Education

The public today with all its complicated issues has need for as nearly objective sources of information as possible. But, I am convinced after observing the fine work that many of our educational foundations, institutes, and centers have performed in the public policy area that this is not enough. The public wants many sources located in their own regions and states. The land grant colleges are in a unique position to fulfill this role.

The requests for educational assistance with community problems is growing. It is interesting that we now have a vigorous National Community Development Organization with many professional people from the land grant colleges as members. Community development is public policy at the local level.

The several sets of leaflets, prepared by specialists in the various states and sponsored and published by the National Educational Policy Committee, the Farm Foundation, and the Federal Extension Service and in certain instances through the cooperation of the institutes at Iowa and North Carolina and the Illinois and the Ohio agricultural experiment stations have made a start in the preparation of educational materials. With time, the quality and clarity of these types of publications can be improved and their numbers increased.

However, as necessary as publications and mass media are to public policy education, they must be backed up by eyeball to eyeball presentations if they are to get into the public policy dialogue of those who make policy. Public policy education must be directed to the total groups that make the public decisions on an issue. Public policy educators working with adults must be sensitive to the values and knowledge of the groups with whom they are working. This is necessary so that the groups' time is not wasted on either unimportant or known facts.

Daniel M. Ogden, Jr. in speaking before the National Educational Policy Conference in 1971 said: "Public policy in the American political system is made within power clusters which operate with remarkable independence from one another within the common constitutional and political party structure. Each power cluster consists of administrative agencies, executive review staff, legislative committees, interest groups, influential private citizens, and attentive publics who center their public policy concerns and activity primarily in one broad policy area. Most power clusters operate at all levels of government."

It is desirable that the educator working in a given area has credibility with such groups. That is usually necessary if he is to be effective. This does not mean he has to agree with the cluster as there is usually much difference of opinion within the cluster. But, the educator needs to be accepted as a credible person by the cluster.

I asked J. B. Kohlmeyer, a colleague of mine, who has spent most of his life at all levels of public policy education, what his most significant observation in the public policy field was. In essence, it was the implication for policy education which developed from the discovery that two men of good will, equally well informed concerning a policy issue, could come to quite different conclusions. Since any one solution cannot be scientifically proven superior to another, the challenge is to do educational work in this area.

R. F. Spitze said:

> I believe the most important guideline for teaching public agricultural policy is to remember one's status as an educator; that is, to be as objective as possible, yet humanly so. To proceed otherwise is to risk subtracting the individual value-formation process of each person, which is indispensable to the truly public policy-making function of a democratic society. —Indoctrination or promotion, no matter how well reasoned its origin or the years of experience behind

it, or the stature of the professional dispensing it, has little place in public policy education.

For many years, I sought—like many others, I am sure—that ultimate role in which I could serve. accomplish some end, crusade for a cause. As I attempted to be an educator in public policy, I could help society to have ever-expanding reliable knowledge, to understand, and to solve problems. I was not crusading anymore for an end, but rather for an intellectual process. (P. 92)

Keynes said in his *Essays on Persuasion:* "If economists could arrange to get themselves thought of as humble competent people, on a level with the dentist, that would be splendid" (p. 373). We need in every state university a minimum critical mass of at least four people in the public policy area with the characteristics set forth by Spitze and Keynes.

Summary

We have made some progress in public policy education in the last one-half century. We have developed an educational approach to controversial public issues. We have had some limited success with specific programs. We have legitimatized the educational function of public policy education to a considerable degree. Is it just possible in the period ahead that the land grant colleges through a cadre of practically minded, scholarly economists could add to that public policy knowledge stream in such a way that it would make a difference. For the sake of the nation, I think it is worth a try.

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Unstable Farm Prices: Economic Consequences and Policy Options

K. L. Robinson

The external environment confronting both farmers and policy makers obviously has changed dramatically over the past three years. Grain surpluses in the hands of the government have disappeared, drought has cut crop production in several important areas, and the news media have rediscovered the fact that a high proportion of the world's population subsists on diets which even in good crop years are only marginally adequate. In the United States, food prices, and especially the prices of grains, have risen to levels thought highly improbable only three or four years ago. Does the new environment call for equally dramatic shifts in policy? This is the question I have been asked to discuss.

I am under no illusion that one more paper on the subject of U.S. agricultural policy will significantly alter the course of human events. In a world of shortages, however, it is reassuring to know there is still a surplus of at least one item, namely advice on policy matters. The threat of redundancy obviously looms large over anyone who has the temerity to accept an invitation to address the American Agricultural Economics Association on this topic. Whoever does so must expect to operate in an area where the marginal utility of additional information is very low; my hope is that I have been able to identify an area where it is still positive.

The subsequent analysis is based on the premise that price instability in grains rather than the threat of shortages or surpluses will be the dominant issue facing policy makers in the United States over the next few years. I will argue first, that price instability is not all bad, or to put it slightly differently, that within the profession there is a tendency to overvalue price stability as an objective of policy and second, that only modest changes in our existing institutions and policies are required to deal with the current situation.

The discussion will be confined mainly to problems associated with instability in the prices of grains and soybeans. Cotton, tobacco, peanuts, rice, sugar, and perishable commodities will be ignored except insofar as they are affected by policies adopted for grains. There are compelling political as well as economic reasons for doing so. Agricultural policy debates in Washington have been dominated for over fifty years by the question of what to do about the prices of a small group of commodities, principally wheat, corn, cotton, and dairy products. Recent events have not altered this situation. Congress lost interest in trying to deal directly with the prices of perishable commodities in the late 1940s following the disastrous experience with support programs for potatoes and eggs. In the intervening years, administrators as well as politicians have shown great reluctance to take on new programs involving perishable commodities because of regional conflicts among producers, resistance to the acceptance of effective controls, and concern about the potential high costs of government intervention. Furthermore, there is the practical problem of what can be done to stabilize the prices of such commodities as potatoes, onions, apples, and eggs. In theory, it might be possible through the use of such instruments as marketing orders to reduce fluctuations in prices or to even out returns to producers (although not market prices) by taxing commodities in high priced years to build up a fund out of which payments might be made in low priced years, but in practice such programs would be difficult to implement even if sufficient support could be mobilized to get the necessary enabling legislation enacted.

In contrast, with storable commodities such as grains and cotton, a well-tested array of policy instruments is available which could be

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Invited address.

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The author is indebted to his colleagues, B. F. Stanton and W. G. Tomek, for their constructive comments on an earlier draft.

used to moderate price instability including a public storage program, price-support loans, and various methods of adjusting or controlling supply. Political reality dictates that we focus attention on those commodities for which we have available the necessary policy instruments and a strong base of political support for government intervention. Dairy products as well as grains fall in this category, but because both the issues involved in attempting to stabilize dairy prices and the policy instruments are somewhat different, they, too, will be ignored. Policies adopted with respect to grains obviously do influence the prices of livestock products and substitute crops as well. These secondary effects will be considered, but the important point to keep in mind is that most policy discussions, now as in the past, focus on grains and tend to ignore the rest of agriculture. I plead guilty to following this well-established tradition.

Nature of the Problem

For much of U.S. agriculture, the price situation, apart from an accelerated rate of inflation, has not been radically altered by recent events. Growth of internal demand has been relatively stable and predictable. Sudden shifts in export demand combined with general inflation and the elimination of excess storage holdings are mainly responsible for the turnaround in farm prices. Wheat, feed grains, and soybeans have been most directly affected. Prices of these commodities now fluctuate more within a few weeks than they did during the entire decade of the 1960s. For example, over the past year, harvest-period futures prices for wheat have ranged from less than \$3 to over \$5 per bushel and soybean prices from under \$5 to over \$8 per bushel. As long as present provisions of the Agriculture and Consumer Protection Act of 1973 remain in effect, such instability is likely to persist. The act was designed deliberately to avoid the accumulation of large reserve stocks in the hands of the government by keeping loan rates for wheat, feed grains, and cotton at relatively low levels.

The hazards of forecasting future prices under present conditions are well known to this group. I have no new information or insights which would enable me to improve on our generally poor record of performance over the past three years. I am not persuaded, however, that actual market prices will fluctuate around a generally rising trend of real prices as suggested by Cochrane a year ago. If this were true, it would create a relatively comfortable environment for those advocating a build up of stocks. But if real prices decline once again as they did during the 1960s, losses incurred either by private traders or the government could be substantial. I prefer a neutral stance. In this respect, my views closely parallel those of Brandow. He concluded a year ago that "it would be disastrous to make a specific forecast, to prepare to deal only with one outcome, and to find ourselves locked in when a very different outcome in fact develops" (p. 1099).

The problem as I see it is not one of potential physical shortages, at least not for U.S. consumers or for that matter most of the countries that buy from us, but rather one of unstable prices. The United States has sufficient productive capacity to meet any anticipated changes in effective demand over the next five to ten years. Avoiding shortages is simply a question of providing adequate incentives for producers. Even temporary shortfalls in production need not prove disastrous for American consumers. The absolute supply of grain per person is so large that physical shortages are extremely unlikely. Livestock output provides a very flexible buffer to cushion the effects of changes in domestic supply or external demand for grains. Prices will effectively ration the available supply in years of short crops and high demand, just as they have done with corn and other feed grains during the past year. The chief disadvantage of relying solely on market forces to allocate supplies and guide production is that this may lead to extremely unstable prices, with accompanying cobweb effects on livestock output, adverse consumer reaction when prices escalate, and possibly a depression in agriculture if farmers overreact to temporary high prices. In short, the current mix of policies may well produce results which are beyond the limits of political acceptability. This is the critical policy question. Should we attempt to reduce the potential amplitude of price swings by altering existing policies? Before attempting to answer this question, I believe it appropriate to examine more fully the consequences of increased price instability both for producers and consumers.

Economic Consequences of Price Instability

Price changes during the past three years have been overwhelmingly in one direction. Consequently, we have not had a full test of what might happen if present policies (which permit market forces to reign) were maintained over a period of years. One of the important effects thus far has been to redistribute income from grain users to grain producers. Income transfers to grain producers over the past three years far exceed those resulting from government programs adopted during the 1960s. One has only to look at the changes in average net farm income since 1972 in grain-producing states such as North Dakota relative to grain-consuming states such as New York to be conscious of the power of relative prices to redistribute income.

The high level of grain prices also has achieved what advocates of meatless days failed to do last year, namely reduce meat consumption. This was brought about simply by making it unprofitable for livestock feeders to maintain per capita production of fed beef and pork. Altering price relationships is an extremely effective method of reducing the amount of grain fed to livestock and making more available for human consumption.

Effects on Agricultural Output and Efficiency

One of the standard arguments advanced in favor of attempting to stabilize grain prices is that this will lead to greater stability in livestock output and, consequently, more stable livestock prices as well. My own conclusion, based on an analysis of price behavior over the past decade is that, while stabilizing grain prices may be a necessary condition, such a policy by itself is not sufficient to produce stability in livestock output or prices. Our policies were successful in stabilizing prices of feed grains over the period from 1960 to 1971 to a far greater degree than in any preceding decade. Season average corn prices over a period of nearly fifteen years ranged from a low of just under $1.00 per bushel to a high of $1.33. The ratio of high to low prices in the 1960s was only 1.33. In contrast, during the period from 1921 to 1929, about the only other period I could identify with a reasonably comparable degree of stability in overall demand, the ratio of high to low season average prices for corn was 2.04 (table 1). But the degree of instability in the prices of hogs and eggs in the more recent period was not reduced to the same degree. In fact, egg prices were slightly more unstable in the 1960s than in the 1920s despite more stable corn prices in recent years, or at least up to 1972. Alternative measures of price instability including the coefficient of variation in season average prices and the ratio of high to low prices for each of the two periods produced similar results.

Table 1. Relative Stability in Annual or Season Average Farm Prices of Selected Commodities, 1921–29 and 1960–71

	Coefficient of Variation		Maximum-Minimum Price Ratio	
Commodity	1921–29	1960–71	1921–29	1960–71
Wheat	0.15	0.18	1.55	1.65
Corn	0.18	0.08	2.04	1.33
Eggs	0.07	0.08	1.22	1.28
Hogs	0.18	0.16	1.70	1.54

Source: USDA, *Agricultural Statistics*.

While this is a relatively crude test of the linkage between feed grain and livestock prices, the evidence is sufficiently strong to make one cautious in assuming that stabilizing grain prices will automatically stabilize livestock prices. It is certainly plausible to argue that the amplitude of fluctuations in livestock output will be less with stable grain prices, but it is clear from an examination of time-series data that cycles in egg and pork production persisted in the 1960s much the same as in the more distant past despite more stable feed costs. Prices of livestock products continued to fluctuate with changes in production. Stabilizing the denominator of the livestock/feed price ratio did not lead to stability in output. This is not an argument against stabilizing grain prices but rather an admonition not to expect too much from stabilizing feed prices alone.

One additional interesting fact emerges from the analysis of season average prices for wheat in the same two time periods. Both measures of variability (the ratio of high to low and the coefficient of variation) were slightly higher in the most recent period than in the earlier period (table 1). Average market prices for wheat were more unstable than those for corn in the decade of the 1960s because of

changes in policy. The assumption often made by advocates of government intervention that such intervention will automatically lead to more stable prices is not always correct. Changes in policy or in administrative decisions can produce as much instability as market forces. Government intervention, unless carefully circumscribed and managed, can become a destabilizing factor in pricing farm products, as dairymen learned to their dismay in 1974.

Another familiar complaint against unstable prices is that this leads to capital rationing, thereby reducing output and efficiency. It is difficult to test the theory empirically because, in most cases, the assumption that other factors influencing output and efficiency remain the same is not fulfilled. The availability of new technology and the level of prices in relation to costs probably are more important variables than is price stability per se. The dominance of these other factors is clearly illustrated in the fruit, vegetable, egg, and poultry industries. Large capital investments and rapid improvements in technology have been made in recent decades despite highly unstable prices.

There has been a tendency in the profession to accept too uncritically the argument linking capital rationing to price uncertainty put forward so convincingly by D. Gale Johnson nearly three decades ago. Conventional wisdom now holds that unstable prices inhibit capital investment in agriculture. Empirical observation, however, suggests the possibility of an alternative hypothesis linking capital investment positively with price instability. The chain of reasoning is as follows. A substantial part of investment in agriculture occurs in years of high prices since such years provide both the capacity to invest and the incentive, partly because farmers are notorious "tax avoiders." Farmers have a high propensity to invest out of retained earnings which, of course, are positively correlated with prices. Recent sales figures of farm equipment dealers lend support to this hypothesis. Thus, it is possible that the sum of investments over a period of years may be greater with unstable prices and incomes than with more stable prices although the evidence obtained by Girao, Tomek, and Mount, who examined the investment behavior of a sample of Minnesota farmers, is far from conclusive on this point.

The effect of periodic low prices on efficiency also must be considered. Efficiency is partly a function of forcing managers to make changes in their business or weeding out those with inferior ability. Gains in efficiency, as Leibenstein has emphasized, are achieved not so much by changing the output mix along the production possibility frontier or by altering factor proportions, but rather by moving from well inside the boundary toward the frontier or simply by producing more output with the same set of resources. This he calls "X-efficiency." Improvements in "X-efficiency" are likely to be associated with occasional periods of low prices. During such periods, farmers who use resources inefficiently are forced to make changes. If not, their creditors usually suggest they consider alternative ways of earning a living.

What I have suggested is a cyclical theory of changes in investment and efficiency in agriculture. Investment comes in lumpy forms and is facilitated by high prices; inefficiency is squeezed out in periods of low prices. Stability can lead to complacency rather than to efficiency although this certainly is not always the case.

Among the more serious repercussions of unstable prices are the potential adverse effects on the farm equipment industry and the inflationary impact of high commodity prices on land values. Occasional booms in farm equipment sales, followed by periods of depression compound the problem of trying to achieve a tolerable degree of stability in nonfarm sectors of the economy. Unstable prices also can have a ratchet effect on land values. I am reminded of S. W. Warren's observation on the behavior of potato farmers who obviously have operated under an unstable price regime for many years. After a trip to Aroostook County, Maine, he summed up the situation this way: "In a poor year, farmers go into debt, while in a good year, they buy another farm." This tendency to overcapitalize the good years puts a floor under costs that may be difficult to live with in the future. I am told that in some areas of the Midwest recent land sales and rental rates which reflect these prices now make the land cost of growing corn close to a dollar a bushel. This puts young farmers and creditors in a very vulnerable position.

Effect on Consumers

In theory, the effect of unstable prices on consumers is to reduce total utility (Johnson) but to increase consumer surplus (Waugh) as compared with stable prices. The different ef-

fects are produced by slicing the area under the conventional downward sloping demand curve in two directions. If one slices the area vertically so that successive segments represent changes in total utility, then it is obvious that increments in utility associated with low prices are smaller than those associated with high prices. But if the area is sliced horizontally so as to represent changes in consumer surplus, each segment becomes larger as one moves down the vertical axis. This means that consumers gain at low prices more than they lose at high prices. Whether consumers are better off with stable or unstable prices thus depends in part on what is to be maximized: total utility or consumer surplus. Theoretical arguments for and against price stability become even more complex if net changes in producer surplus are taken into consideration as well as changes in consumer surplus. (The literature on this topic and the conditions under which consumers and producers can expect to gain from price stability are well summarized in a recent article by Turnovsky.)

In practice, consumers are concerned mainly with the threat of high prices. They want protection against escalation in food costs. Flexibility on the downward side in average farm prices is frequently offset by rising nonfarm costs of processing and distribution; thus, consumers usually are unaware of price decreases at the farm. Most were oblivious of the fact that average prices received by farmers for livestock and livestock products dropped 35% between August 1973 and June 1974.

Food prices have become more politically sensitive in the past few years. As a result, changes in the food component of the consumer price index are now given disproportionate attention by the news media. Early in 1975, optimism over the course of inflation was attributable mainly to a slower rate of increase (and even a brief decline) in food costs; the turnaround in the food component of the CPI between May and June precipitated fears that a new round of inflation is imminent. What most commentators fail to realize is that changes in marketing costs and the farm prices of beef, sugar, fruits, and vegetables, all items over which we have relatively little control at present, contribute far more to inflation or deflation in food prices than Russian grain deals or other developments that have a major impact on the price of grains and soybeans. An examination of the relative importance of commodity groups included in the food component of the index makes this abundantly clear. Products derived from grain are given a weight of less than 3% in the total index whereas perishable items account for about 12% (table 2).

In order to isolate the effect of farm-level price changes on the CPI, I have taken the analysis a step further and calculated farm-level weights. This has been done by multiplying each retail component by the appropriate farmer's share ratio derived from the U.S. Department of Agriculture's market basket statistics. For grains, the estimated farm weight in the CPI is only 0.6% (table 2). Even a doubling of grain prices would now add less

Table 2. Relative Importance of Food and Farm Products in the Consumer Price Index

Component	Relative Importance at Retail Dec. 1974	Farmers' Share[a]	Estimated Weight of Farm Products in CPI
	%	%	%
Food at home			
Cereals and bakery products	2.9	20.6	0.6
Meat, poultry, and fish	6.1	54.7	3.3
Dairy products	2.9	46.2	1.3
Fruits and vegetables	3.1	26.7	0.8
All other	4.6	29.4	1.4
Total	19.7		7.4
Food away from home	5.1		
Nonfood items and services	75.2		
	100.0		

Sources: USDA, *Marketing and Transportation Situation;* U.S. Dep. of Labor.
[a] Based on USDA market basket of farm foods using the farm value of each category divided by the retail cost.

Table 3. Approximate Direct and Indirect Effect on Annual Average per Capita Food Costs of a 2¢ per Pound Change in the Price of Wheat, Feed Grains, and Soybeans

	Effect on Annual per Capita Food Cost	
Commodity Group	Direct[a]	Indirect (livestock)[b]
	$/person	
Wheat	$3.00	$ .80
Feed grains	2.68	29.00
Soybeans	2.04	2.62
Total	$7.72	$32.42

Source: USDA, *Feed Grain Situation* and *Wheat Situation*.
[a] Based on 1973–74 per capita disappearance of grain for domestic food and industrial use, including use in alcoholic beverages, corn syrup, and starch.
[b] Based on 1973–74 per capita use of grains in feeding livestock.

than 1% to the overall index. If all farm prices were doubled, with no changes in marketing costs, the CPI could be expected to rise somewhere between 7% and 8%.

An alternative way of estimating the effect on consumers of changes in grain prices is to calculate multipliers which show the indirect effect (through livestock) as well as the direct effect on average per capita food expenditures of a unit change in prices (table 3). This can be done by applying incremental changes in prices to per capita disappearance figures. Aggregate domestic disappearance figures for wheat, feed grains, soybean oil, and soybean meal have been converted into per capita estimates. Direct use includes the amounts which go into alcoholic beverages, corn syrup, and even starch as well as flour and breakfast foods. Indirect use includes all grains used in feeding livestock. The per capita disappearance figures have been multiplied by an assumed change in the unit value of each product of 2¢ per pound. This multiplier was selected because it represents a change of around $1.00 per bushel in the average price of grains ($1.12 for corn and $1.20 for wheat and soybeans).

These multipliers indicate that a change of slightly more than $1.00 per bushel in average grain prices at the farm will change per capita food expenditures directly by no more than $8 per year. This is probably an overestimate since no adjustment has been made for byproduct credits. If wheat alone were to rise, the effects would be even less. For example, if Russian purchases were assumed to add as much as $1.00 per bushel to the price of wheat, the direct effect on consumers would amount to no more than $3 per capita. This is less than the effect on consumers of a 5¢ per pound change in the price of raw sugar, a product whose price has varied over a much wider range than wheat during the past twelve months.

The potential indirect effects of changes in grain prices are much greater. Indirect grain use per person (that is, consumption of grain through livestock) amounts to about five times the direct use. Thus, if increases in grain prices were fully reflected in the prices of livestock products, the average annual increase in food costs associated with a 2¢ per pound increase in grain prices would amount to slightly more than $30 per person. Lags in adjustment to changing feed costs obviously will affect the timing of changes in livestock prices. In any one year such changes will not correspond closely to changes in feed costs. What the multipliers indicate is how much a given change in feed costs is likely to affect livestock prices in the long run, assuming nonfeed costs remain the same.

The full effects (combining the direct and indirect costs) of a $1.00 change up or down in grain prices are not likely to exceed $40 per person per year. This is equivalent to less than 1% of per capita disposable income. Thus, reducing price variability in grains by as much as $1 per bushel, while perhaps politically important, can make only a modest contribution to the objective of achieving overall stability in consumer expenditures for food. It may be worthwhile to do so, but again, we should be cautious about promising too much.

One of the more compelling reasons for attempting to reduce price swings in grains is to preserve our export markets. Periodic high prices can be accommodated quite readily (if not willingly) by domestic consumers simply by altering the composition of their diet, but threats of unavailability or high prices may lead importing countries to seek substitutes elsewhere or to adopt still more protectionist policies in an effort to encourage home production.

Food aid also may become a victim of price instability if the demand for food aid rises at a time when grain prices are already high. Past experience suggests a positive correlation between our willingness to offer food aid and the size of surplus stocks. At present we lack flexibility in being able to respond promptly

and positively to the needs of developing countries simply because there are no readily available stocks on which we can draw. I deplore making food aid dependent on the presence of surplus stocks but recognize that political risks are involved in offering more aid at a time when inflation in food prices is a sensitive issue.

Policy Recommendations

In the foregoing analysis, I have tried to identify the consequences of continuing the existing set of policies which simply means relying mainly on market forces to guide production and consumption. The policy question raised earlier still remains to be answered. Do we need a new set of policies designed to curtail potential price instability and to increase government-held reserves of grains? My answer is yes, but the changes I am about to suggest are relatively modest and do not deviate in principle from those adopted in the past, except for the manner in which we handle food aid. I am persuaded that farmers do need some protection against very low prices, that they should be encouraged to increase production, and that both farmers and private traders should be offered incentives to carry larger stocks than in the past since this is the only real protection consumers have against continued escalation in food costs. I would not be unhappy to see the government acquire modest amounts of grain in protecting farmers against a sudden decline in prices, but I do not think it necessary to go into the market and buy stocks to hold. Finally, I think it essential to modify food aid policies so as to provide more flexibility. I believe acceptable compromises can be devised which will achieve these objectives at very little increase in cost to the government and/or to consumers. The elements of such a policy are as follows: (*a*) a system of support prices for all grains, linked to a single commodity such as corn or wheat and adjusted annually to reflect changes in nonland costs of producing that commodity; (*b*) a government storage program for grains, but with a much wider range between acquisition and selling prices than in the past; (*c*) standby provisions for adjusting land use if necessary; and (*d*) increased flexibility in committing funds for the purchase of commodities to meet food aid requirements.

Congress is more likely to give favorable consideration to modifications which build on past experience than to proposals which break new ground. For this reason, I would argue strongly in favor of retaining something like the old price-support loan and storage program. The system served the interests of both producers and consumers reasonably well during the decade of the 1960s although at considerable public cost. We can improve on the system by maintaining supports at a modest level and by widening the range over which prices are permitted to fluctuate in response to market forces.

One requirement of an improved price policy is to devise a better system of determining support prices or loan rates for individual commodities. The existing parity formula does not provide a reasonable basis for establishing floor prices. I suggest the possibility of linking support prices for all grains, soybeans, and cotton to a single commodity through the use of appropriate price ratios, and then to adjust prices up or down on the basis of changes in nonland costs of producing the key commodity.[1] For purposes of illustration, I have selected corn as the key commodity. To establish the base, I have made some rough calculations of changes in nonland costs of growing an acre of corn in the Midwest, taking into account increases in the cost of fertilizer, seed, fuel, machinery, and labor. When divided by the estimated yield, this turns out to be $.60 per bushel higher than in 1972. This figure when added to the loan rate prevailing before the recent export boom comes to $1.65 per bushel. Farm management studies indicate the current nonland costs of producing a bushel of corn are somewhere in this neighborhood. To provide additional incentive for farmers to maintain production, one might consider raising the loan rate to somewhere between $1.70 and $1.80 per bushel. It should then be adjusted upward in subsequent years on the basis of changes in nonland costs. By excluding land costs, I would hope to avoid capitalizing current land values into support prices.

Too little consideration has been given in the past to establishing reasonable price relationships among commodities. Floor prices for grains should be established at a level which will permit substitution of one commod-

[1] Establishing a system of floor prices for all grains will have the effect of maintaining a floor under the prices of other annual crops as well, especially those grown for processing, which compete with corn and soybeans for the use of land.

Table 4. Illustrative Price-Support Loan Rates Based on Corn Prices Adjusted for Changes in Nonland Costs Since 1972 and Intercommodity Price Relationships Prevailing in the Period 1966–71

Commodity	Prices Relative to Corn, 1966–71	Price-Support Loan Rates
		$/bu.
Corn	1:1	$1.80
Wheat	1.19:1	2.14
Soybeans	2.31:1	4.16

ity for another in feeding livestock. In the case of wheat, this will occur in areas where wheat is abundant and corn or other feed grains are scarce when the national average price of wheat is around 20% above the price of corn. For crops which are not direct substitutes in consumption, but compete for land use, such as soybeans and cotton, relative prices should be established at a level which will yield comparable returns to the fixed factors of production. A recent study of the relationship between soybeans and other crops by Boutwell, Harris, and Kenyon et al. indicates that with a price of corn of about $1.80, the price of soybeans should be close to $4.50 per bushel (2.5 times the price of corn) in the Midwest to yield equal returns per acre above variable costs. Studies of this kind also could be used to determine an appropriate floor price for cotton by tying it to the price of soybeans.

For illustrative purposes, I have calculated a set of price-support loan prices that I think would be appropriate, based on current input costs and historical price relationships (table 4). The latter are not necessarily the most appropriate ratios to use, but they might serve as a useful guide. The resulting floor prices (per bushel) are $1.80 for corn, $2.14 for wheat, and $4.16 for soybeans. Keep in mind that these are simply the lower boundaries. Actual market prices in most years should exceed these levels and by varying amounts for different commodities.

The Commodity Credit Corporation presumably would acquire surplus commodities at the loan rate, just as in the past. In the 1960s, however, the CCC was authorized to sell commodities it had acquired at 15% over the loan rate. This spread is much too narrow. To provide an incentive for farmers and traders to hold grain for up to three or four years, resale prices should be at least 50% to 60% above the newly established loan rates. I would suggest that the margin for grains be maintained at not less than $1 per bushel. Carrying storage stocks is expensive and consumers should expect to pay for this service regardless of who holds the stocks. With this much spread between the floor price and the resale price, farmers, traders, and possibly even importing countries would be much more willing to hold stocks than in the past. They did not do so in the 1960s because there was little prospect of earning a profit from private storage. Modest changes in the rules of the game should be sufficient to restore incentives and provide the flexibility we need to cope with unstable export demands. Thus, we need not embark on a massive new purchase program with specific acquisition targets in mind.

It also seems to me appropriate to provide some assistance to farmers in adjusting production if our projections of demand turn out to be incorrect. Farmers are being asked to supply a residual market which can be extremely unstable. A strong case can be made for socializing some of the potential cost of providing the needed flexibility in production. This can be done by retaining the option of paying farmers to keep land idle if storage holdings again become too large.

Finally, we need to divorce food aid from support operations and to devise a more flexible method of funding so that we can respond promptly to changes in food needs of developing countries. There is no justification in my view for asking farmers to subsidize food aid indirectly by producing surpluses at low prices, nor is it morally responsible for the United States to tie food aid to the availability of surplus stocks.

Food aid requirements are likely to be highly unstable from year to year and difficult to predict, but in total the amount of grain required over a period of years is likely to be small in relation to overall production and the amount of grain exported commercially. During the past two years, for example, food aid shipments have accounted for less than 3% of total U.S. grain production and only about 5% of exports.

The essential element in providing additional food aid is to increase appropriations so that purchases can be made on the open market whenever needed. We can rely on market forces to achieve the necessary diversion of supplies. The price and income effects on consumers of any additional diversion required are not likely to be very large. To provide

additional flexibility, a new institution might be created with the authority to borrow against future appropriations. Alternatively, Congress might authorize expenditures over a period of years but not require those administering the program to commit all the funds in any one year. I would hope the expenditure ceiling could be raised without getting sidetracked by arguments over whether food aid should be used primarily to achieve strategic or humanitarian objectives, to foster economic development, or to promote new markets for U.S. farm products. I am more concerned with increasing the size of the pie than with deciding how it should be divided.

You will note the omission of any reference thus far to export controls or target prices. The short-run interests of consumers in holding down domestic prices are less important than the long-run interest of the United States in maintaining markets and earning foreign exchange. We should not jeopardize our reputation as a reliable supplier of farm products by imposing export controls.

There is insufficient time to discuss fully the merits or demerits of target prices and deficiency payments. I have strong reservations, however, regarding their use as a device to support farm incomes. These reservations are based on considerations of cost and equity. There is danger that target or guaranteed prices will be established at a level which will necessitate large income transfers. Furthermore, as long as benefits are tied to particular commodities, and bases are historically determined, the distribution of benefits will be highly skewed. If we need to supplement the incomes of farmers, I hope that more equitable means of doing so can be devised.

Conclusion

The policy recommendations I have put forward are based on the implicit assumption that there exists an optimum degree of price variability. I am not sure just where the optimum lies along the scale between zero and infinity, but our experience over the past two decades suggests the mix of policies we had in the 1960s fell short of the optimum, while the policies embodied in the 1973 act are likely to exceed the optimum. Reduced to its simplest form, my argument is that we should not abandon the principle of establishing upper and lower boundaries to price fluctuations for important export commodities such as grains and soybeans, but that we should widen the range over which market forces are permitted to operate as compared to the 1960s. We can improve on existing policies by devising a more satisfactory method of adjusting support prices, by increasing the spread between CCC acquisition and resale prices, and by providing more flexibility in committing funds for food aid.

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Opportunities and Responsibilities of Agricultural Economists: A General View

Lee R. Kolmer

The title "Opportunities and Responsibilities of Agricultural Economists" is really a question of how agricultural economists can be more useful as we look into the future. There is no single answer to this question, but the changed conditions of today as compared to as recently as three to five years ago dictate that we must recognize the environmental change that has taken place around us.

We are in a different political world than we were as recently as five years ago. The upsurge of consumer advocacy and the thrust of the consumer movement into the areas of food and fiber production and disposition are a real political force today. We can expect this to continue. The consumers and their advocates represent a larger portion of the congressional constituency than ever before. During the same period, the political influence of the farmer has declined. This decline in political influence is offset to some extent by a new awareness of the importance of food in international negotiations. International considerations do, at times, come into conflict with the short-term interest of consumers. As consumers experience increases in the cost of food, their judgment of their own best interest does not very often reflect the long-range implications of the role of food production in achieving a stronger economy through trade policies that improve our balance of payments. The political implications of this short-run versus longer-run conflict are reflected in the pronouncements of the legislative and executive offices in government. While we are all aware of the changing political climate, we have not yet felt the full impact of this upon the agricultural economy, both the farm and nonfarm portions.

The economic climate is also changing. The very rapid and large shifts in factor and product-price relationships that have occurred during the past several years have upset many of the production relationships with which we had become accustomed.

While our political and economic climate has changed dramatically during the past half decade, agriculture is at the same time undergoing quite a significant change in the social environment in which it operates. The increasing regulation and constraint being placed on the agricultural production process is just beginning to be felt by many producers. The commitment to clean water and reduced pesticide residues has hampered the production process in many farming areas. In addition, it increases production costs and managerial uncertainty.

The increased concern on the part of the general public for the production of a social product from agriculture as well as an economic product is another idea that is gaining credence among many people in this society. The idea that agriculture should contribute a substantial amount of social product in the form of open space, green belts, wildlife habitat, and recreation to the total society has much more support today than it did as recently as five to ten years ago. In one sense, more and more people of this society are viewing the agricultural resource as a national resource to be managed for the benefit of the total society as compared to a private resource that is to be managed solely for the maximization of profit for those who are engaged in agriculture.

I am telling you nothing new—agricultural economists have been observing these changes and reacting to them. But what do these changes do to the farmer and to the agriculture-related industry? Have you asked farmers or people in agribusiness? I have asked many people and I get a wide variety of answers—some specific and some more gen-

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This and the following two papers comprised a panel discussion, "Opportunities and Responsibilities of Agricultural Economists," moderated by Kenneth R. Farrell, Economic Research Service, U.S. Department of Agriculture.

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eral. The combination of changes has increased costs, added to uncertainty, and is the cause of much frustration. The added uncertainty and the frustration have helped to create a substantial amount of cynicism on the part of producers. This combination of uncertainty, frustration, and cynicism can create a climate that is hostile to thoughtful consideration of the impact of various policy alternatives upon the individual farm. While the impact is different in different geographical areas and in different commodities, there has been an increase in the uncertainty and managerial frustration in every area of the agricultural industry.

The increased uncertainty has been accompanied by a decline in the flexibility and alternatives available for many farmers and agribusiness firms. The proliferation of regulations, paper, red tape, and constraints have resulted in some decline in the flexibility available to modern agriculture.

Given this environment, what are the opportunities and responsibilities facing agricultural economists in the future? I believe the first task is to assess the changes in the environment as they relate to the particular state or company or agency in which we are employed and ask how the theory and knowledge that agricultural economists have can help the agricultural industry as it attempts to cope with increased uncertainty, greater constraint, and larger capital requirements in coming years. While we are all well aware that these changes have taken place, I believe there must be a deliberate recognition of the impacts of changes as they relate to our individual positions so that we, as individuals, can remain in tune with what is happening in the real world.

To keep in touch with rapidly changing reality, I believe that agricultural economists must listen to what people are saying. We must listen to other professionals in our institutions and agencies, to political leaders, to farmers, to agribusiness personnel and others, including the consumer advocates and environmentalists. They have their concerns and feelings about how and where professional agricultural economists can be useful. I think also we must listen to what is not being said by these same people as they talk about the future and their plans for meeting the issues of the day. If their comments and pronouncements reflect only very narrow, shortsighted concerns, they and others who hold the same views may be advocating policies that will harm their own best interests in the longer run. Without such listening we run a grave risk of developing a professional posture that has little relationship to the very significant problems that the agricultural industry must cope with during the next decade. Put another way, I believe that if agricultural economists are to be useful as professionals, we must be used by our clientele and audiences and we can't be used if we do not address the problems that these groups have.

I believe that a great opportunity and a very significant responsibility exists to help the people in agriculture in matters relating to policy during the next decade. Agricultural economists must spend some time and thought determining the appropriate methods for disseminating the information that we have as it relates to a specific audience. I believe this is one of the significant weaknesses of all professional groups in a period such as we are in now. We have spent much talent and energy in developing quite sophisticated and very valuable research techniques which provide a wealth of information and material that can be extremely valuable to a potential user, but it must be presented in a way that is understandable and usable to that potential user in his circumstances. I do not mean to suggest that the results of our research be watered down or that our research be any less rigorous but rather that we put the same imagination and effort into making it useful and usable for our potential user as we do in devising the research methodology to obtain such information. I am reminded of an Oregon wheat farmer's remark. He said, "Lee, the agricultural economists say that what I am doing isn't profitable, but I have the records to show that it is." He said this prior to knowing that I was an economist. We can slough off such comments by saying that it may be profitable, but it wasn't maximizing profitability for his resource combination, or we could say that his accounting system did not truly account for all inputs involved in the enterprise. This attitude would, in my judgment, beg the question. The question really is "Why did he feel constrained to make this comment?" Someone failed in the educational task of bringing information to him as a manager of a farming operation. If we have widespread failure of this nature during the coming decade, our usefulness to the agricultural industry will be very seriously diminished.

As stated above, I believe the changes that have taken place offer great opportunities for agricultural economists. Our past research provides a wealth of information that is applicable to policy makers and managers in government, in business, on the farm, and in agencies today. We have the information, but we must devise improved methods of transmitting this information to managers.

Society is going through a substantial rethinking process related to natural resource policy, conservation policy, and land use policies. These are critical areas for the well-being of American agriculture today and in the future. Economists have much to contribute to this policy debate if they decide that it is important for them to take the time and to make the effort to inject results of their research and observations into the policy arena.

The opportunity to contribute to the formation of policies which will govern agriculture during the next several decades is perhaps the greatest challenge we face at the present time. It is often slow and frustrating as we attempt to inject objectivity and rationality into the policy debate. This, however, makes it all the more important that we persist. The cost of not accepting this challenge and pursuing it aggressively can be very great for agriculture and for rural America. If we do not aggressively seek ways to extend the findings of our research into the policy debate, I believe we have failed our responsibility to the society.

The changing environment also offers new opportunities for production economics and farm management. Producers face problems that they did not face several years ago. They are especially frustrated in their attempts to manage the increased uncertainties they face today. The recognition of this as an area of concern for research and education is, I believe, of paramount importance for agricultural economists at the present time. Many producers are ill equipped to manage this additional uncertainty; farm managers and production economists can provide much help to the agricultural industry in this area during the next several years.

The changing price relationships and political environment have contributed to a resurgence and interest in marketing and transportation problems facing agriculture. In my judgment our record in these areas has not been very good. However, I believe our record is much better than it appears to be in the eyes of our constituents. There is, however, a new awareness of marketing and transportation problems in agriculture. I believe we have information and knowledge that can be very valuable to farmers and agribusiness firms at the present time. Again, there is the need to address the problem and aggressively seek out opportunities to make our contribution in this area.

The combination of events that has triggered these very substantial changes in the agricultural industry during the past five years has also opened up opportunities for team research such as did not exist in a more stable and placid time. The combination of animal scientists, agronomists, entomologists, wildlife biologists, and economists working on significant policy issues or production management questions is substantially greater today than it was a few years ago. There has been dramatic proof during the past several years that teams of agricultural scientists can indeed change or modify the direction of agricultural policy if they elect to work together as a team rather than as isolated individuals. If professional economists persist in "going it alone," I do not believe we will make the impact that we can. I would say the same thing to animal scientists, agronomists, entomologists or any other group concerned with problems in agriculture today.

The recognition of the opportunity for effective team research and extension and the commitment to such activity cannot just come from economists. It must also come from other disciplines. This, I believe, is one of the challenges that faces administrators of agricultural colleges, agencies, government agencies, and agribusiness firms. In universities there is a great temptation for scientists to talk to each other through refereed journals. The reward system fosters this practice. This is true in too many ways at my own institution, and I am quite certain it is true at many other institutions. However, this does not make it right or necessarily useful under today's conditions. Today's problems require the talents of numerous disciplines, and administrators must modify reward systems so that individual research and extension staff members can indeed see that commitment to teamwork will not only produce useful output for our clientele but also will result in recognition of their efforts. This is a very substantial challenge for those of us in administrative positions in universities.

Opportunity brings with it responsibility. Agricultural economists have many opportunities today, and we also have very serious responsibilities. I am convinced that we have the dedication and commitment to meet these responsibilities and exploit the opportunities. However, we could miss the boat because we did not take the time and effort to identify the breadth and depth of the problems facing agriculture; we could miss the boat because the administrative environment in which you as individuals operate was not conducive to this type of endeavor; or we could miss the boat because we just didn't make the effort to determine how and where we could be useful to people in a very rapidly changing world.

Opportunities and Responsibilities of Agricultural Economists: Colleges of Agriculture

J. E. Legates

My perspective in this discussion will be to consider primarily how the services of economists can be more widely utilized within our educational network. In this context opportunities and responsibilities for economists in colleges of agriculture arise as the mission to provide the research, education, and training support for the clientele of our land grant college system is accepted.

While developing principles and dispensing knowledge, we must recognize that we are about a larger task of stimulating and training leadership for our professions, for agribusiness, and allied fields which are likely to be users of our servicers. In the classroom I suspect that generally we have focused sharply to gain the interest and stimulate the enthusiasm of potential majors in our fields, but it is possible that we may not have entered into the teaching of nonmajors with equal zeal. Economists must recognize that those who come from other departments and disciplines may indeed be our strongest supporters in the years ahead. They are extremely important as a part of the future contingent of lay economists. The statement which Philip Handler, president of the National Academy of Sciences, made about science in general is relevant to and true of each discipline: "I must remind you that a religion with naught but a priesthood, no matter how enthusiastic, devoted or dedicated, but without a laity cannot long survive" (p. 981). Our information and services must be carried to grass roots. Economics must come alive, and students must see that economics can make a contribution. Despite our own dedication, we cannot fulfill our meaningful mission solely within the confines of our professional society or within the university community.

In research and extension apart from the teaching function, the clientele which your departments have been called upon to serve have of necessity attained higher levels of sophistication. New and broader dimensions of agriculture have brought many additional subjects and users within the realm of your responsibility. Farm management, production economics, and marketing continue to be essential and important concerns, but needs for rural development, natural and human resource economics, and others have been articulated to define a broader and more intricate role of agricultural economists in our present setting.

Disciplines like agricultural economics, which are based on derived sciences, have the difficult and yet essential responsibility, to provide an appropriate balance between the exploitation of principles and fundamentals and the use of energies and assets to solve pressing practical problems. Extending fundamental thinking is germane to providing a firmer base for guiding solutions to practical problems. Yet there is no payoff, in the minds of many, until the information is used by public and private decision makers or at least by other professionals. You as professionals must champion necessary fundamental inquiry and continue to convince administrators that it is an essential component of practical problem solving.

A most important responsibility in this setting is to insure a proper perspective in assessing the available problems. Pertinent to this is the policy of colleges of agriculture to appoint economists and house them almost exclusively in their parent departments. I am not convinced that this has been a productive strategy. It does present a situation with economics which is not encountered in certain other disciplines. In most agricultural colleges faculty with professional competencies in botany, genetics, microbiology, and physiol-

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ogy are found within the commodity departments. This tends to generate a high level of interaction between faculty with commodity and disciplinary interests. Economic and business considerations have always been important in agriculture, even if they have not been emphasized sufficiently. Now emphasis on them has become compelling, and we must do even more to foster a productive interrelationship between faculty in economics and those in other departments of our colleges of agriculture.

While all faculty in economic research would not necessarily maintain day-to-day liaison with their research counterparts in other departments, such liaison must be encouraged and stimulated with more vigor than has generally been the practice. Joint or associate appointments for some economists in other departments deserve consideration. Animal and plant scientists are still largely biologically oriented, and they interact almost daily with other scientists in parallel disciplines. Hence, economists must be more agressive in taking their ideas to the animal and plant scientists, particularly if economic implications are to be incorporated meaningfully into research projects. All too often the search for something of economic significance is undertaken or even considered only after the data are already at hand.

Extension-research interactions are extremely important in assessing the relevant problems to attack. As extension workers visit with farmers, processors, marketers, input suppliers and consumers, they gain information that can be most helpful in focusing on what their clientele feel are appropriate questions that deserve attention. More contact by researchers with these groups could be stimulating. Further extension-research dialogue is essential to expedite implementation of findings, once the researcher has been successful in gaining a solution to the problem.

Even in extension, emphasis and choices are most difficult. Requests will continue to come to make the decisions, rather than to provide the basis for decision making. Guidance and even leading may be necessary to retain the confidence of your users, but decentralization of decision making and increasing the level of economic literacy among supporting workers is of paramount importance. This will involve time and effort in discussions with colleagues on the campus and in training extension personnel in the field. Nonetheless, this will extend economists' impact and free them to develop innovative approaches to other educational projects which are already waiting in line. Sufficient emphasis in these programs with field economists must be given to unique commodity problems, so that substantial information is provided that can be useful to the producers and other clientele whom they must serve. This could be your entrée to their continuing acceptance of information regarding a basic economics and more general policy issues, which are deserving of special emphasis.

You are aware that dealing with commodity groups and maintaining credibility and appropriate professional relationships can be a very precarious and challenging undertaking. If these groups are to accept our recommendations, they must sense that we understand their problems in the field. Too often economic recommendations have been referred to as suggestions for "pencil profits." This brings to mind the statement attributed to President Eisenhower when he said that farming looks mighty easy when your plow is a pencil, and you are a hundred miles from the corn field. We shall have an opportunity to serve those in the field only when we get close enough to the "corn field" to fully understand their problems.

A very special opportunity exists for economists to sensitize our farmer clientele to the importance of proper handling of credit. Investments in agriculture have risen almost exponentially. Many know the cultural and husbandry methods explicitly, but they are woefully inadequate in managing their resources. Farm records programs now provide data from which educational projects can be developed. This is an important and challenging area where broader and more complete economic understanding must be imparted.

Challenges and opportunities are always available to those who are willing to seek them out. I propose that economics must be made to come alive to students, professional colleagues and lay adults. More consistent and persistent efforts must be made by economists to interact with colleagues in other disciplines and with various commodity interests. Extension workers must continue vigorously to provide training programs that will enhance economic literacy and decentralize economic

decision making. Strong research-extension interactions must be fostered to focus on important research problems and to expedite implementation of research findings. It is important that colleges of agriculture provide essential research, education, and training to keep agriculture competitive and productive. Each of you must maintain that special degree of balance that allows you to listen to those who have specific problems, but at the same time permits you to retain the responsibility for directing your programs.

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Opportunities and Responsibilities of Agricultural Economists: Journal Publications

Raymond J. Miller

All professional societies are responsible for planning and maintaining an adequate system of journal publications. Scientists, be they physical, biological, or social are expected to accomplish a number of things through the publication of research in journals. First, they place their findings in a system of checks and balances. The only people really capable of judging whether research and its results are valid and should be published are other experts in the immediate area of the author. Second, the theory, ideas, and research results are entered into a permanent record where they can be tested and evaluated over time. Third, research findings provide a means of determining the quality and quantity of the scientists work and, therefore, are used in judging a person's professional status and contribution.

Before discussing in more detail the above points, the different types of publication outlets and their audiences are considered. There are, in general, three types of audiences—all are important. First, there is the professional who is conducting research in the same area or who uses the ideas and information in his own research. Second, there is the professional not conducting research but who uses the information in decision making or planning, and third, there are the people who disseminate the information to others who in turn use it in their decision making.

To communicate with the above audiences, appropriate avenues of publication must exist. These range from refereed journals, through textbooks and review articles, to bulletins, current information series, and quick communications between scientists. The information in these latter outlets is only as good as the quality of the information in the refereed journals and they should form the basis for the work that goes into all other publications. If the system of refereed journals is inadequate, then the total system is inadequate, and a proper system of checks and balances does not exist.

If the total system is inadequate, it is often because there are not enough outlets through the professional societies, who must be the ones setting the standards. This deficiency of publications may take several forms. For example, it may be that there are just too few pages; the publications may cover the various disciplines of the profession but are not published often enough or in large enough volume. Another form of deficiency may be that a profession tends to reserve its publication for the more fundamental or theoretical work and neglects the work which applies and tests those theories or vice versa. Any of these situations is bad and tends to foster in-house publications. Even though in-house publications are usually reviewed internally, they have not been reviewed by experts outside of the unit doing the publishing. As a result, such publications have not usually been reviewed by other experts in the field and have not entered the system of checks and balances. One very bad result is that the wheel is too often reinvented. Another is that too much science is repetitious because people are not aware of something someone else has done or are not willing to extrapolate from one state or situation to another with a minimum of testing. An adequate literature and review of that literature helps avoid these pitfalls.

The above system when working properly determines quality, as peers are continually scrutinizing. Such scrutinizing will also keep the literature from being padded and repetitious and inconsequential work from being published. One of the main indexes of a scientist's productivity is their number of publications. Many say this is bad and has become known as publish or perish. But it isn't if the above

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Table 1. Number of Members, Journals, and Average Number of Pages Published a Year by Three Professions

Profession	Approximate Number of Members	Journal	Pages/Year (three-year average)	Pages/ Member
Agricultural economics	3,800	*Amer. J. Agr. Econ.*	1,012	0.27
Agronomy	8,091	*Soil Sci. Soc. Amer. Proc.*	1,017	
		Crop Sci.	885	
		Agron. J.	987	
		J. Environ. Qual.	438	
		J. Agr. Educ.	?	
		Crops & Soil	270	
		Soil Survey Hort.	?	
			3,597	0.44
Animal sciences				
Animal science		*J. Anim. Sci.*	1,400	
Dairy science	9,000	*J. Dairy Sci.*	1,788	
Poultry federation		*J. Poultry Sci.*	2,348	
			5,536	0.62

system is working. A person who discovers many new things has many new papers to publish or the better the scientist, the more new things there will be to publish. This was verified in a detailed study by Shaw. He found that a person doing a lot has more to publish and that in most cases the more a person does the chances are that the quality will also be better if the above system is operating. So there seems to be a relation between quantity and quality.

It must be emphasized that agricultural economists, like people in all other areas of science, must work more with other disciplines. They must also learn to communicate so other than their own will understand it. But before agricultural economists can communicate with others, they must communicate better among themselves.

Do the different professional societies, plus other refereed journals, fill the publication needs of the professionals in various areas? That is a hard question to answer and any comparison is somewhat arbitrary. Table 1 compares three of the larger agricultural subject matter areas in the United States. These are agricultural economics, agronomy, and animal sciences (determined by combining the areas of animal, dairy, and poultry sciences). From table 1 it is seen that the approximate number of members in each area differs, but so do the number of publications and the pages per year. Agricultural economics publishes the fewest pages per member per year of any of these professional areas.

All professionals have access to numerous journals other than those of their society. In a recent report sixty-nine journals were used to determine the source of authorship for each article during the three-year period 1967–69 (Salisbury, Grossman, and Anderson). These journals were chosen as the major journals for agriculture. Of these sixty-nine journals, agricultural economists published in twenty-two, agronomists in forty-one, and animal scientists in thirty-five. It was also found that even though the scientists were publishing in many places that their society publications accounted for the largest percentage of the publications (table 2).

Upon studying tables 1 and 2, it would appear that compared to the other two subject matter areas, agricultural economics publishes fewer articles in journals and that the American Agricultural Economics Association has too small an outlet for its professional works.

Table 2. Journal Publications as a Percentage of Tabulated Publications for Selected Professional Areas, 1967–69.

Journal	Cumulative % of Publications
J. Farm Econ.	57
Crop Sci.	22
Agron. J.	43
Soil Sci. Soc. Amer. Proc.	58
J. Poultry Sci.	28
J. Anim. Sci.	52
J. Dairy Sci.	71

Source: Salisbury, Grossman, and Anderson.

Two committees appointed by the AAEA have studied its publication policies and made several recommendations. The report of the Smith Committee dealt with several issues. Their recommendations on publications were essentially that more pages covering a wider spectrum of topics was needed; that a newsletter be published, thus removing some material from the *Journal*; and that symposia be held with appropriate issues and reviews published. Subsequent to the Smith Committee, another committee was appointed to make specific recommendations on the kind and amount of material that the AAEA should publish and the form in which it should be published. The committee report (Baker) makes six recommendations, only one of which really addresses the question of more publication space. They recommended a publication, *Current Comment*, but did not make firm suggestions as to content, etc.

If the preceeding thoughts and analysis are even partially correct, it would seem that the AAEA needs to increase its publication outlets. I would suggest that this be in the form of another journal dealing mostly with 'applied' agricultural economics. Any such journal must take into consideration the timeliness of an article and allow for projections and speculations by authors. These latter views may often be different than those of reviewers and care must be exercised not to eliminate such thoughts just because of differences of opinion. The topic of timeliness is often given as one reason why agricultural economics uses a lot of in-house publications. It is an important issue, but timeliness is also important to most professional areas. I doubt that such problems are unique and it is likely that if a topic is timely, it is for more than one state or region. It is possible that a publication with a very short turn-around time is also needed. This has been done in a number of biological areas.

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Specific Sessions

Preparing the Undergraduate for the World of Work: Industry or Academia? (Wayne D. Purcell, Oklahoma State University, Chairman)

Perspective from the Grain Trade

Willard R. Sparks

My remarks reflect primarily my experience and observations at Cook Industries and more specifically, the Agri-Products Group. This group is involved in merchandising grains, oilseeds, oilseed products, feed ingredients, and cotton on a worldwide basis. Other segments of our Agri-Products Group include elevator operations, processing operations, and the entire infrastructure that augments commodity trading.

We hire individuals from a wide variety of backgrounds. I believe this to be logical for two reasons: it is very difficult, if not impossible, to stereotype individuals as the only type suitable for a particular job, and the qualifications of various jobs differ. For example, Cook's Agri-Products Group is divided into a grain division, a processing and refining division, a cotton division, a controller's department, ocean freight operations, economic research, and European operations. There is a need for special qualifications and/or special assignments within this breakdown.

With this background, let's turn to what Cook is looking for in a young person to fit the basic role of our business. In commodity merchandising management, we consider the following attributes. Grades are not keenly important as long as they are reasonable (A–C), but we like to see how a person has applied himself or herself. A person's record is examined to observe progress, as many may be late starters. Also, we are interested in his/her activities, not just the number, but the kind of activity and the scope of responsibility. Aggressiveness takes different forms, but we need go getters and self starters, people who involve themselves and make things happen. A person must be able to communicate with people in order to extract information and get things done. A person must listen to and hear what people are saying (very important to working in markets). One characteristic that is important is a person's ability to make decisions and not always be qualifying recommendations. We need people who can stand up to constant pressure. A good sense of humor is a must to survive in commodity merchandising. A person must be analytical; he or she must be a quick thinker who likes to play with numbers and sort out answers on an ongoing basis. A person must have a strong curiosity to find out how markets work. We need people who cannot be pushed around and who can defend his or her point of view. With respect to academic background, traditional strong liberal arts courses are producing the majority of management-oriented grain merchants in grain companies. As a general rule, we are looking for students with backgrounds combining such subjects as economics, English, history, philosophy, mathematics, languages, and political science.

I feel real progress has been made in identifying the type of person we strive to hire. We look for people who can grasp relevant situations. For example, what are the impacts of changes in price support levels, changes in supply-demand situations for major crops, dry weather in Russia, spread relationships between various markets and commodities, supply and demand for freight, and feeding relationships? Second, the person needs to be able to sort out the main issues and get to the heart of the matter right away. Third, the person must be objective. The price paid for a commodity or the company's position today may not be relevant in assessing the market for tomorrow. Fourth, decision making is extremely important. A person can be a good analyst, be objective, and identify main issues, but if he fails to act on the basis of his

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information, the marketing opportunity is lost. Finally, the person should make things happen to create profits. After all this is what business is all about.

In interviewing, we have found that most undergraduates take only the survey courses in political science, history, and philosophy. Language requirements are nonexistent in many schools. In English, in addition to literature, there is a need to stress speech and business letter writing, so the young graduate can better express himself both orally and by letter. In math subjects, there is a need to learn the application. Price analysis courses appear to be weak, as many young people are not aware of the many government statistics or their meaning in price work.

Cook is a young company in the grain-merchandising business, but we have been expanding rapidly during the past few years. As a consequence, Cook has not been able to afford the time lag that typically exists from the time a young person is hired until he or she is fully productive. When a person is hired, he or she has already passed a fairly rigid screening process. In our program, a young person is expected to make minor decisions within three months time, fairly significant decisions within six months, and major decisions when he or she has been on the job eighteen months. This apparently is faster than occurs in other major grain companies which have a more ample supply of merchants from past recruiting programs.

Maturity of the individual is very important to us. In this respect, graduate degrees or time in the military are valuable as a maturing process. As far as grain merchandising is concerned, however, it does not appear to make much difference what degree a person has after he has been on the job two years, but maturity helps a person off to a good start particularly when we push him or her to responsibilities as fast as we do.

Our experience with cooperative work-study programs may not be typical. I am sure they are very beneficial to certain students. As far as grain merchandising is concerned, they are probably overemphasized and nonproductive. They can provide exposure and a summer job, but the student is not really going to learn the basics of grain merchandising because one has to "do" to learn and we prefer to let our permanent people be the ones "doing."

The way a company goes about interviewing can influence the results. In the past, when our needs were not as great as present, we would often call people we know at certain schools and ask them to send us the names of their best students. This past year, Cook expanded its interviewing effort to reach more schools, and different types of schools. In addition, we have sent our management and merchandising people to do most of the interviewing. While this is expensive, it helps identify the type of person we want to hire. We have found that personnel people just cannot pick good merchandising prospects.

A summary of our experience for 1974 follows. This year fourteen interviewers, ten merchants and four nonmerchants, visited twenty-eight universities and talked with approximately 420 students. We invited 48 students to Memphis for second interviews and offered jobs to 20 of them; 13 of these accepted our offer, one of which is for processing and refining as an operations trainee.

Of the twenty-eight schools visited, six were business schools. We invited eleven M.B.A.'s to Memphis for second interviews, or 23% of the total students invited to Memphis. Jobs were offered to nine of these which represents 82% of those M.B.A.'s invited and 45% of the total job offers. Six M.B.A.'s accepted our offer or a 67% acceptance rate. The average Memphis rating of the forty-eight total students interviewed in Memphis was 1.2[1] and the average M.B.A. score was 1.9. The average Memphis rating of the twenty students offered jobs was 1.9 and the average M.B.A. score of those offered jobs was 2.1.

We visited twenty-two schools to talk with students about to receive their B.A./B.S. degrees or M.A./M.S. degrees. These schools represent 79% of the campuses visited. We invited twelve M.A.'s/M.S.'s to Memphis for second interviews or 25% of the total. We offered jobs to only one of these which represents 8% of those graduate students invited to Memphis and 5% of the total job offers. The one man offered a job did not accept. The average Memphis rating of the twelve graduate students was 0.9 compared to the overall average of 1.2. The score of the one man offered a job was a strong 2.6 compared with 1.9 for the total job offers.

We invited twenty-five B.A.'s/B.S.'s to Memphis for second interviews of 52% of the total. We offered jobs to ten people or 40% of

[1] The interviewer rating is based on a rating of 0 (not acceptable) to 3 (exceptional candidate).

the undergraduates who were invited to Memphis. This represents 50% of the total job offers. Seven of this group are coming to work for Cook which is a 70% acceptance rate. The average Memphis rating of the B.A.'s/B.S.'s was 1.1 compared to the overall 1.2. The average Memphis rating of this group offered jobs was 1.7 compared to 1.9 for the total job offers.

In addition to looking at the results from the point of view of degrees, I have analyzed "types" of schools classified as "agriculture oriented," "Ivy League," and "others." Of the twenty-eight agricultural schools visited, ten involved interviews with agricultural economic areas of 36% of our total interviews. We invited twenty-one agricultural economics students to Memphis for second interviews or 44% of the total. We offered jobs to six of these which represents 29% of those agricultural students invited and 30% of the total job offers. Three agricultural students accepted our offer or a 50% acceptance rate. The average Memphis rating of the forty-eight total students interviewed in Memphis was 1.2 and the average agricultural score was 1.1. The average Memphis rating of the twenty students offered jobs was 1.9 and the average agricultural score of those offered jobs was 1.8.

We interviewed at five Ivy League schools out of twenty-eight or 18% of the total. We invited fourteen students from these schools to Memphis for second interviews which made up 29% of the total invited. Jobs were offered to nine of these which represents 64% of those Ivy League students invited and 45% of the total job offers. Seven from the Ivy League accepted our offer or 78% acceptance rate. The average Memphis rating for the fourteen students from this group was 1.5 compared to the overall 1.2. The average Memphis rating of the Ivy League group offered jobs was 1.9 compared to the overall 1.9.

Of the other twenty-eight schools visited, thirteen were neither agriculture oriented or Ivy League. This represents 46% of the total. We invited thirteen of the "other" group to Memphis for second interviews of 27% of the total invited to Memphis. Jobs were offered to five people or 38% of the ones in this group who came to Memphis and 25% of the total job offers. Three accepted our offer for a 60% acceptance rate. The average Memphis rating of the forty-eight total students interviewed in Memphis was 1.2 and the average "other" score was 1.0. The average Memphis rating of the twenty students offered jobs was 1.9 and the average "other" score of those offered jobs was 2.0.

In sum the figures show we did a reasonably good job in balancing the types of schools visited and types of students invited to Memphis. The results in Memphis are a different story. M.B.A.'s represented only 21% of the schools visited and 23% of those invited to Memphis, but make up 46% of our 1975 recruited training group. M.A.'s/M.S.'s made up 25% of those invited to Memphis but only 5% were offered jobs and none accepted. B.A.'s/B.S.'s made up 52% of those invited to Memphis and 54% of our 1975 recruited training group. We either did a poor job of recruiting M.A.'s/M.S.'s or this group is not generally oriented to grain merchandising. Looking at the results in a different way, 36% of the schools visited were agriculture oriented or the departments in which we interviewed were agriculture departments. Forty-four percent of the total invited to Memphis were agricultural types, but only 23% are represented in our 1975 group. On the other hand, only 18% of the schools visited were Ivy League and only 29% of the total invited to Memphis were Ivy League, yet 54% of our 1975 recruited group are from eastern schools of the Ivy League type. Forty-six percent of the schools visited were neither agricultural or Ivy League types and 23% of our recruited class are from this "other" group.

I recommend that universities strengthen and emphasize traditional liberal arts courses and that students avoid taking specialty courses such as "Grain Marketing" in place of economics or other fundamental B.A. courses. However, seminars and/or specialty courses which stimulate student interest are good. Continue to stress courses or activities which help the student develop as a mature person. Courses in human relations would be helpful. Good teachers can do more than specific courses in stimulating students. The most important thing a student can learn is how to think. What he learns in college may have a fairly short shelf life, but if he has learned how to think, he can cope with new situations and continue to apply what he has learned in college and on the job to new situations. When we find a young person who can think we will make a job for him if there is not already an opening waiting.

Perspective from the Meat-Packing Industry

Patrick J. Luby

The American Agricultural Economics Association in its annual program and in its official *Journal* has given considerable platform in the last decade to the general topic under discussion in this session. As recently as one year ago at the annual meeting of the AAEA, our chairman chaired a session, "Interfacing the Classroom and the World of Work," which included two fine papers by Milton M. Snodgrass and Charles E. French. They discussed the issues of whether and how to bring the undergraduate student to the "real world" and the "real world" to the student.

Snodgrass and French laid an excellent philosophical framework for our discussion. Snodgrass stated:

> During a period of study leading to a baccalaureate degree, most agricultural economists would likely agree that a student should develop a capacity for: (1) critical analysis and problem solving, (2) taking a responsible position in society, (3) forming a philosophy of life—living harmoniously with one's self, other people, and the physical world, and (4) continuing one's education. Using more general categories, the objectives of a university education might be considered to fall into two groups: the first pertains to individual development for self understanding and fulfillment, good citizenship, and living harmoniously with other people and the physical environment, and the second involves career education which includes the component of developing some employable skills. In curricular discussions among agricultural economists, there are wide variations among the percentage emphasis that each of these two areas should receive. (Pp. 1154–55)

French stated that in the four years of undergraduate study that teachers "have a huge job to get across the general ideas of: (1) developing the discipline of thinking . . . ; (2) conceptualizing with various degrees of abstraction the situations within which analysis by thought or otherwise takes place; and (3) bringing to bear wisdom of the past, theoretical generalizations, analysis techniques, and means of creativity on problems of working and living" (p. 1173). Thus, the student is being prepared for the "problems of working and living" and the question is what is "the percentage emphasis that each of these two areas should receive?"

Snodgrass poses one of the issues to be discussed. How much of the four years of undergraduate education in agricultural economics and business management should be devoted to "individual development for self understanding and fulfillment, good citizenship, and living harmoniously with other people and the physical environment" and how much to "career education which includes the component of developing some employable skills"? And I am sure that this is not a new subject to any of you. Each of you involved in teaching or the administration of departments involved in teaching has directed much energy and thought to this matter. As noted earlier, the AAEA has given considerable time to the subject in its meetings and space to the subject in its *Journal*. Three years ago, a special three-day workshop on the Improvement of Education in Agricultural Economics was held by the AAEA at the University of Florida. This workshop focused attention on many matters, including this session's subject. Thus, it is presumptuous of me to think that I can add significantly to the body of knowledge that we have accumulated in this area. However, according to our chairman, interest in and arguments about the subject continue briskly and I am most happy to be a part of the discussion.

Most holders of undergraduate degrees in agricultural economics and business administration enter the meat-packing industry in one of three general capacities—production, sales, or livestock buying. Some others enter into other specialized staff areas associated with marketing, procurement, finance, personnel, industrial engineering, and others.

When we recruit undergraduates we hope to

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obtain persons who will have, of course, promotability to management positions but also flexibility and mobility. Therefore, we opt for students who have a good, broad, general background in subject matter. However, I do not mean so general that the curriculum has been disjointed and nearly completely elective. If the student is an agricultural economics or business management graduate, we would expect a good, solid selection of courses within the major. But we would also look for course work in the sciences and would be very impressed with good work in communications. In our particular industry, we would be delighted with a solid minor in meat and animal science. In other parts of agribusiness, a different agricultural minor might be more appropriate but, I would think, similarly desirable.

From the viewpoint of the total welfare of the graduate, I believe that a reasonable compromise between a general background and specific courses developing specific employable skills is desirable. It is asking quite a bit to choose one's lifework at age nineteen or twenty. Keeping one's options open as long as feasible seems to be in the student's self-interest and also in the collective best interest of society. Having an optimum "fit" between the person and the occupation should improve not only the total output of goods and services per unit of input but also the more difficult to measure other than economic standard of living of the population.

However, there is a reasonable limit to how long and how much luxury a student can have before choosing a productive occupation. It seems reasonable that during the undergraduate days a student be expected to develop skills that will make him or her productive and contributive to his or her and others' welfare almost immediately upon graduation. And in our firm, and in the others with which I have spoken in preparing for this discussion, the student is expected to be able to enter productive employment with relatively little initial training by the firm.

With the exception of positions requiring specialized professional skills such as engineering, accounting, chemistry, law, and other positions requiring particular and specialized experience or training, we do not attempt to hire for particular divisions of our company students of particular course work or curriculum. We believe that the fundamentals are about the same. To be able to sell or to buy or to manage a working crew or to function well in most positions, one must be able to think and analyze quickly and clearly, to make correct judgments and to communicate quickly and effectively with others. One must be able to anticipate, recognize, and analyze important occurrences, problems, and opportunities, decide the optimum course of action, communicate the decisions and reasons for them to others, and perhaps lead but at least work well with others to carry out the decided upon course of action. Personality and other characteristics and the preferences of students for the different kinds of positions, we believe, are more important in their placement than the differences in their course work.

There are some trends in the world of work that you are very aware of but which may bear repeating. The body and complexity of knowledge required continues to multiply. Changes of all kinds increase rapidly. The interdependence of nations, industries, firms in a supplier-user relationship, and persons within a productive group is increasing. This means that employees must either know more or, more importantly, know how to know more. The problems, opportunities, and decisions are likely to occur more frequently with faster change. And the need for effective and speedy communication becomes greater and that which is communicated becomes more complex.

These trends lead us to the increasing importance of education. It is important to employees and to employers more than ever before. And I agree with French who last year said that "professors know more about education than employers" and the "many general items expected by the employer of the student can be taught best by the professor" (p. 1163). Better education is required in today's world of work, and the good university is the most effective and should be the most efficient place for it to be done.

These trends in the world of work also lead us to the needs in education from the employer's point of view. We demand a lot from the educator. We are asking for a product that not only will not depreciate in five, seven, or ten years like many of our other inputs, but one that will appreciate and remain effective for forty or more years in a rapidly changing environment. Thus, it is more important to produce a product or graduate that is capable of changing and learning and growing than a product for a particular task in a par-

ticular time frame. It is more important to produce a graduate who can efficiently find and comprehend pertinent information for the next forty years because the quantity and importance of the new knowledge and information developed during the next forty years will be greater than all that is now known. In addition, in today's and tomorrow's interdependent world, more and more goods and services are and will be produced and marketed by specialists working together so that the need to communicate information and ideas effectively grows steadily.

With these trends, the formal education of the student must be somwhat general. Those who move up the corporate ladder most rapidly tend to be those who gained considerable breadth either in formal education or in continuing education while on the job. However, the realism in the world of work is also such that in the vast majority of cases one must produce something of value fairly rapidly. In today's competitive market, it is likely that one must have marketable skills. I think education is called upon to strike that balance and I think that such a balance well serves the student, the employer, and society.

In his excellent communication to us in preparation for this session, the chairman suggested several areas of discussion on more specifics in the what-to-teach and how-to-teach in "preparing the undergraduate for the world of work." I believe that educators know more about the how-to-educate and it is presumptuous for me to think that I can add greatly to the store of knowledge in this area. However, in order to respond to the chairman's suggestions, I interviewed some of our employees, all graduates of departments in agriculture schools within the last decade or so. They have all entered our company through one of three training programs, the premanagement training, operations training, or sales training programs. They have worked and progressed with our company since their graduation. This is not an adequate sample nor is it random and, therefore, cannot be necessarily representative. They are not all graduates of departments of agricultural economics, but they do represent examples of products of agricultural colleges who are working in industry.

I asked questions concerning the curriculum—what has been of greatest use, least use? What would you have liked to have added, deleted? What kinds of instruction were most valuable—lectures, case studies, field trips, visiting lectures, special programs and reports, computer games, etc.? What was the relative value of extracurricular activities on campus? Should they be increased or decreased? Would you have liked to have had more specific preparation for the world of work?

It is difficult to gain any particular consensus from such a relatively small number of conversations. However, some tendencies did emerge. Most were fairly happy with their undergraduate training and clearly could name more courses they would like to have taken than courses they would like to have deleted. They agreed with French when he said last year that "four years is preciously short" (p. 1173).

All would like to have taken more work in decision analysis. Some mentioned that they would like to have had more commodity demand and supply analysis including futures markets. Most would have liked to have had more accounting. All expressed that they would like to have had either more course work in speaking and writing, or much better yet, more experiences in speaking and writing worked into their various courses of study. Comments were made on the importance of being able to sell oneself, one's products or services, or one's ideas, verbally or in writing, and being unprepared by undergraduate experience to do so effectively. The ability to analyze and define a problem and opportunity and various courses of action quickly and possibly on one's feet at short notice was deemed necessary in industry and not prepared for properly in undergraduate studies.

There were mixed reviews for many of the various methods of instruction but most favored more case study approaches to course work. They also favored more use of special problems, projects, and papers. They desired as much simulation of the environment of corporate decision making as possible. However, there was no strong feeling that computer games were the best approach. Regarding computers, most thought that the undergraduate should get a thorough understanding of the capabilities, value, and use of computers in business, but saw no reason to invest very much time learning the intricacies of programming.

In summary, the graduates I talked with who have worked with us felt that they had received a good education, a good

background, and adequate training for the world of work in agribusiness. They realize that not all graduates go to work for business firms and that a collegiate curriculum cannot be designed for such graduates alone. They realize that some students change their minds on career choices several times during undergraduate days and that considerable breadth must be maintained to permit such mobility. But with the ability of hindsight and with the perspective of employment in an agribusiness firm, most would have desired more work in courses helping to improve analyses of problems, decision-making processes, and various methods of communications. Most now say that they wish there had been more use made of the case study method and more opportunity for the student to develop analyses, decision-making and communication skills in course work and/or in extracurricular activities on campus.

As an employer, we are looking for individuals who have leadership ability, a desire to work, an ability to work with others, and an ability to break down a problem and opportunity, arrive quickly at an appropriate course of action and communicate to others the action and reasons for it. We would like the breadth of educational background which permits the employee to see the broad and interlocking pieces of corporate and industry operations and hence, makes him more promotable to levels of broader responsibilities. Yet, we also like the employee to come to us with useful and marketable skills which permit almost immediate productivity. We would like an employee who knows more about how to obtain information than he knows about how to memorize information. We would like an employee with a lifelong commitment to continuing personal education and improvement because some of one's formal education and training tends to be forgotten or becomes obsolete over time.

Having said all of this, I can understand French's observation last year that he was "patently unimpressed with the product specifications for recruiting undergraduates laid out by many employers. Usually the employer wants a student with a list of personal, professional, and environmental characteristics never embodied in one young person. Professor and employer are both ill-advised to expect a student to be all things to all people" (p. 1163). I agree with French but such a product specification is still useful as a goal, even if seldom attainable.

Last year, Snodgrass and French reported on cooperative study programs, called "cooperative" or "intern" programs. Our experience with these is generally favorable with proper planning and if used in certain departments. We have had some successes with them and are slowly expanding them in selected areas.

French also analyzed field trips and visiting lecturers. Our experience leads us to conclude that in economics and business management, it is better and more efficient to bring the business manager or the business economist to the classroom than the students and professor to the business location. I agree with French (p. 1168) that the visitor should not lecture but should respond to the students' and professors' questions and comments. In that way, the subject matter covered will be that desired by the teacher in designing the course. It is my feeling that business managers will normally respond favorably to invitations to campus classes and club meetings if the number of hours spent with students per trip is sufficient to justify the use of the total time invested.

My experience and my contacts with others in our company and industry in preparing this paper lead me to conclude that a moderate stance is best on the question of an extremely broad versus extremely narrow undergraduate education in preparation for a career in business. The risks of either extreme are too great to the student and to society.

Regarding the question of methodology, I believe that agricultural economics departments are keeping up with technology and are keeping up with surveying employers and graduates in efforts to increase the productivity of instruction. My experience and observations lead me to agree with almost all of the observations made by French and by Snodgrass at these meetings last year, and I would suggest that if you have overlooked or missed these articles, you try to review them.

Finally, we in industry are indebted to the fine efforts you are making with our young people to prepare them for the world of work as well as the world of living. Much will be demanded of them in both worlds. The preparation of them to meet these demands is an important trust which you have. French put it very well when he stated that you should

selfishly cherish and defend your short exposure to your students (p. 1173).

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Perspective from the Academic Community

James G. Kendrick

Members of departments of agricultural economics are rightly concerned as to how their graduates perform as they accept diverse responsibilities in a multitude of careers. This concern about employers' opinions of our students has undoubtedly precipitated numerous, perhaps continuous review of departmental course offerings and requirements, consuming significant energies of both educators and employers. To neglect this effort would leave a department—our profession—in the stagnant waters of nonrelevancy.

However, I suspect that in many of these curriculum reviews considerable time is devoted to defining the academic qualities an agricultural economist should possess and what functions he should be able to perform in various types of employment—firm, farm, or public agency. Employers have worked with these curriculum study groups to suggest profiles of training. Often the results of such studies could politely be termed excursions in frustration, as opposing visions of the "true" role of academia often find precious little upon which to agree.

Those agricultural economists concerned with the functioning of our graduates tend to mentally associate themselves with two philosophical camps—the specific and the general. I suggest that the profession align itself with a different vision of its proper role in society which more accurately expresses what agricultural economists do best—systems analysis. As I will explain, employers as well as some members of our profession, are at times uneasy in the presence of systems people. If you can temporarily accept a working hypothesis that agricultural economists should neither be specialists nor generalists, I will now try to justify my heretofore implicit position: agricultural economists are ill-prepared to function either as technocrats or as global planners, yet are ideally suited for employment as applied systems-trained problem solvers.

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I believe agricultural economists are most comfortable sitting between the extreme positions of specialists and generalists. When an employer hires a technocrat, a specifically trained individual like a lawyer, accountant, civil engineer, plant or animal breeder, the individual is assumed to be able to perform his or her specialized duties with an absolute minimum of acclimatization. A remark from a personnel director handling specially trained employees might be, "When I hire an accountant and ask, 'Do you know what to do?' he responds 'yes' and does it."

Since the technocrat generally performs specific, predefined functions, it is somewhat unlikely that the specifically trained individual will suggest alternatives to present methods that might make waves and thus rock management's boat.

If the technocrat is not normally a wave maker, one might assume that the antithesis would be the generalist. I don't believe so. If typical liberal arts graduates could be classified as generalists, one might categorize their training as emphasizing the macro interrelationships of the total system and the interfaces that exist among general economic policy, political trends, historical perspectives, and the business community. Often these generalists are able to provide accurate insights concerning long-run realignments in the total system and how those realignments will affect the relationships and profitability of the various subsectors of the economy. Such visions of the future may prove disquieting to management but pose no immediate threat to current operational practices. Employers of generalists have been heard to lament, "When I hire one of those fancy trained college types, their heads are in the clouds and it takes a year or more of hard management training to make them understand how this business (farm, agency) operates and get anything productive out of them."

At the end of the training period, the generalist has learned how the firm (farm, agency) deals with issues of production, marketing, employment, etc., and is then *inte-*

grated as a member of the "team," capable of directing subcomponents of the farm (firm, agency) in concert with overall policy guidelines.

How does the applied systems-trained problem solver (agricultural economists are an example, I believe) differ from the specialist and generalist? I don't believe it is idealistic to suggest that the curricula and other learning experiences at most departments of agricultural economics should be designed to train students to be integrators of specific disciplines; they take perceived concepts or principles from one field and ascertain if the same principles or concepts exist unperceived in other fields and could be utilized to better quantify the consequences of alternative courses of action; they view current operating procedures in a specific time-space environment which is subject to change as soon as these conditions are altered or new concepts of analysis are discovered and understood.

Duane Acker hinted at the systems concept of agricultural economics a number of years ago when he described the difference between one trained in specifics compared to one schooled in integrating principles from various disciplines as follows. "In teaching our courses and in designing our curricula those of us in animal science or agronomy too often put the emphasis on stock being purebred rather than stock being efficient, or rations being nutritionally balanced rather than producing gains at lowest cost, or feedlots being designed for maximum saving of labor rather than being designed for lowest net cost of producing beef, etc." (pp. 276–77).

By designing agricultural economics curricula so that students receive exposure to varied specific disciplines, exposure to the global perspectives of the generalists, and in-depth training to the applied analytical problem-solving tools of economics, we thus produce a product that often approaches the traditional firm (farm, agency) training period with a different orientation than that of either the technocrat or the global planner.

When exposed to a firm's (farm, agency) current *modus operandi,* our systems-trained individual tends to become a victim of his or her past training by soon suggesting investigation into possible alternatives to present operational practices. Such suggestions for change by definition require alteration in existing procedures, which makes waves and thus may tend to make management a bit queasy. As examples of applied systems-trained problem solvers, agricultural economists may not be easily assimilated into an operation that traditionally has functioned with specialists, augmented by team-playing but frustrated would-be global planners. However, the systems individual can perform a function as valuable as the specialist or generalist for a firm in the following sense. Do it this way for now (the specialist) while we explore near-term viable alternatives (the systems individual) and others speculate concerning how we will fit into the changing and dynamic society of the future (the generalist).

Employers who recruit agricultural economists expecting them to fill roles designed for specialists or generalists will tend to experience dissatisfaction in the employer-employee relationship. This dissatisfaction, this misunderstanding of the training of our typical agricultural economic, applied problem solver is often manifested by suggestions for curriculum revision. If these suggested revisions are designed to produce specialists of the technocratic nature similar to the in-depth subject matter competence of an accountant, plant breeder, structural engineer, etc., I suggest that it would be preferable to hire the technocrat directly. Similarly, if the suggested course revisions are designed to produce agricultural economists who are global planners, it would be better to concentrate recruiting efforts in the macro oriented areas of general economics, political science, philosophy, etc.

I do not mean to imply, however, that the misunderstanding of the role of agricultural economists is unidirectional. Assuming again that my concept of agricultural economists has merit, one observes that some departments seem to have designed training programs that attempt to emulate either the specialized training of technocrats or the global orientation of the generalists. At one extreme we observe the explosive proliferation of apprentice training programs and at the other extreme, a reverence of training that emphasizes macro issues, preferably on a national or worldwide scale. Just because agricultural economists have been reasonably proficient in utilizing a systems approach to applied problem solving, it does not automatically follow that agricultural economists are then eminently qualified as philosophers of general employment, national inflation, global resource allocations, etc. Neither are the biochemists, engineers, or animal production specialists in danger of becoming unemployed due to massive intrusions by agricultural economists. When representa-

tives of firms, farms, or agencies suggest to an agricultural economics department curriculum committee that they "leave unto Caesar that which is Caesar's," their counsel should be heeded.

In 1963, when I attended the teaching workshop in Bemidji, Boger defined the objectives of our profession as follows:

> (a) to understand and describe the environment in which farm products are produced, distributed and consumed, including agriculture's social and political institutions, its physical and human resources and the relevant value preferences of its people;
> (b) to refine and extend the principles of economics as they apply in the production, distribution and consumption of farm products;
> (c) to analyze opportunities for fuller attainment of public and private objectives through changes in the use of scarce resources available for production, distribution and consumption of farm products. (P. 28)

If the global political-economic forecasters are reasonably accurate, the remainder of this century might be categorized as becoming people-long and resource-short. For those of us concerned with the alternative organization of resources for efficient production and distribution of food and fiber, it would seem the task is of sufficient magnitude to allow agricultural economists ample opportunity to ply their trade without the necessity of enlarging the territory to encompass other academic disciplines.

The emerging popularity of "on-site," apprentice training for our students carries an implied assumption that we must train for specifics and not use a systems approach. When departments of agricultural economics find it necessary to add courses that mainly duplicate offerings in, for example, sociology, general economics, and political science, then those departments have an inflated vision of the role of agricultural economics in society. I suspect that in some instances departments push for a profile of global courses because many of the staff feel uncomfortable with the tools of systems analysis.

I would encourage all of us—teachers, researchers, extension specialists, and employers in the field of agricultural economics—to review carefully our proper role in a world that requires thoughtful evaluation of near-term alternatives for efficient production of food and fiber. In my judgment, such a profession-wide review would too often reveal departments operating with a philosophy of curriculum structure that attempts to make agricultural economists synonymous with the total educational effort of the university. To attempt to be technocrats, global philosophers, and analysts of alternatives to applied problems is a lot to ask of any profession—even agricultural economics.

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The Role of the Academic Institution

W. D. Downey

It seems ironic that an academic professional area which includes marketing as an important subset would not give more attention to the key micromarketing concepts of demand analysis, product design and development, promotional strategy, distribution, and customer relations for its own product—the student. There are those who would argue that academia has no direct responsibility for marketing its product. But from a pragmatic standpoint, it is difficult to ignore the positive consequences of a growing enrollment and satisfied graduates and employers. The "profit" is in terms of internal budget allocations (although it may lag), research contacts with strategically placed alumni, open doors for cooperative extension work, contacts for placement of future graduates, and positive support in legislative budget allocations, to name a few. The results may be somewhat intangible and long term, but they are increasingly significant in times of growing public emphasis on accountability for the limited resources allocated to the university system.

Business and public organizations are the real consumers of our product. If Purdue is representative, nearly two-thirds of our undergraduates will seek employment with nonfarm firms. Their success will be largely affected by the quality and kind of training they receive.

While we at the university see the student as the "consumer," student demand for our services is actually based on the demand of the final user—the employer. The nature of this derived demand was obvious a few years ago when engineering enrollments tumbled as a result of curtailment of the U.S. space program, and more recently when the difficulty of primary and secondary teachers in finding employment caused enrollments in schools of education to fall off. Although this relationship is not a perfect one, nor rapid in its response, student demand for our services is clearly related to the job market.

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Special Concerns in Attracting Undergraduates

There are some special considerations in marketing our services to the intermediate consumer. The discipline of agricultural economics doesn't have the aura of excitement for most young people that arises from associating with a $50,000 self-propelled harvest machine or a herd of purebred cattle. Students' need to deal with tangible exciting "things" that already have a degree of familiarity often makes it difficult to get their attention as they look over the array of educational packages in the university market place. Increasing numbers of agricultural students are coming without farm experience, nor do they have agribusiness experience that would help them identify with the professional areas of agricultural economics or agribusiness business management.

Consequently, efforts must be taken to give these young people something with which they can identify. This most often is the teacher of the course first exposing them to the discipline—a person who can and will talk their language and will make the subject live for them right where they are.

There is an exciting opportunity to expand the total demand for our services by packaging our courses in ways to appeal to students majoring in other areas of agriculture. By properly packaging courses into meaningful groups of two to four courses and promoting them to nonmajors, we can fill an important need for technical agricultural students who will likely take technical jobs in agribusiness and eventually move into management areas for which they will have little training. This is a market with a great deal of potential.

It is also important to be ready to accept a disproportionate number of students who transfer into an agricultural economics and agribusiness management major late in their undergraduate program. The maturing student who begins to think seriously about his employment opportunities and/or gets a late

exposure to economics and business frequently finds it a surprisingly interesting area in which he sees real personal benefit. Our curriculum must remain flexible enough to accommodate this kind of student and show him how to capitalize on his earlier technical agricultural or scientific courses.

There are excellent opportunities for women trained in agricultural economics and agribusiness management. The acceptance of women into traditional male jobs has been far more rapid and successful in the agricultural area than many have expected or predicted. There is no question that governmental pressures on larger firms have expedited the process, but the result has been many fine opportunities for qualified women. Our discipline provides students with a solid business background and the most flexibility for advancement. The time is right for aggressive recruitment and placement of women.

Once the student has chosen our major, he is for all practical purposes "locked into" our curriculum. He entrusts his development and eventual marketing to the manufacturer—the faculty. This becomes an important responsibility to the management of our production-marketing organization.

Preparing Students for Line Positions

The undergraduate trained in agricultural economics or agribusiness management is most likely to find significantly more opportunities in "line" than "staff" positions. Line jobs are those where he or she will have responsibility for decision making in the organization, at least eventually. Staff or advisory positions almost invariably require specialized or advanced training, generally at the graduate level. Staff people usually have special knowledge and analytical skills and are in a position to give advice to line people but without authority or responsibility to implement the advice. Although much training is useful and common to both line and staff people, failure of curriculum and faculty to recognize the difference can cause significant inadequacies in undergraduate programs.

Faculty generally have not personally experienced the realities of getting along in the business world. Their training has had a staff orientation of problem solving but not decision making, of analyzing, examining alternatives and consequences, perhaps even recommending, but stopping short of making decisions and living with the consequences. This, coupled with professional intellectualism, influences the building of a curriculum that is more relevant for graduate school preparation—if not in rigor, then certainly in required subject matter.

There is no intent here to build a case against teaching theoretical concepts, analytical methods, and sophisticated statistical tools. Instead, it is an attempt to recognize the importance of giving students a balance between pragmatic tools, attitudes, and understanding that can help them be successful in the early part of their professional life as well as conceptual tools for executive level problem solving. Graduates must be successful early in their career before their eventual promotion can occur. In many cases their early success on the job may have little correlation with their college program. But this is not nearly so serious as the rather common situation where a person never reaches his potential because of his lack of ability in handling the rudiments of his early assignments. In the latter case, discontent sets in for the employer and the employee, intensifying with each disappointment and often leading to termination of the relationship. Sometimes a bad experience is a good teacher, but it is usually painful, expensive, and inefficient for both the employer and the employee.

Early in their professional careers, individuals necessarily start at the bottom of the line, essentially carrying out other people's decisions and getting the job done. As they are successful, they grow into positions of greater authority with responsibility for decision making that requires the analytical processes and theoretical concepts they learned in their undergraduate program. Unfortunately, undergraduate programs generally give too little emphasis to skills necessary for success in the early part of the graduate's professional career and concentrate mostly on conceptual skills necessary to their later careers—if they get that far.

Most undergraduate students have had little or no firsthand experience in the business world. Most have never even had a serious discussion with a nonfarm businessman. When they graduate, many still have not had much firsthand contact with business. As a result, they often lack confidence and a sense of reality. They have difficulty in communicat-

ing effectively with employers and other employees. The lack of a realistic understanding of what is expected of them leads to a higher than necessary turnover rate for new employees as they "learn the hard way."

Building a curriculum so that the graduate has a balance between conceptual skills for long-term growth and applied skills for more immediate gains begins with an informed faculty. They must be in tune with employer's and employee's needs. This requires more than a superficial association with business. Occasional faculty visits to key employers are more useful to faculty than vice versa, since the professor is more likely to get a whole new perspective of the business world. How about "trading a day" with a business executive, each spending a day on location with constructive interaction with local staff? Certainly, faculty with open and current lines of communication will be able to relate realism more effectively to their students as a result of such contacts.

Methods of Building Realism into Program

There are many imaginative ways to help give students a better understanding of business and how to live with it. Many of these can be integrated into regular classes often with little effort.

Telelecture or amplified telephone conversation is available through the local phone company and most campuses. A live conversation with business people (or other professionals) can be easily arranged, takes little time from regular class, and allows the instructor to maintain full control of the brief interview rather than forfeit an entire period to an outside lecturer. The system is inexpensive and efficient and gives the student realistic glimpses of specific areas to emphasize a concept.

Guest lectures can be very effective if the lecturer is selected for his communication skills as well as title. If strategically planned ahead, they can really help students understand.

Industry materials used in class give students another glance into the real world. Some of these materials are excellent and are readily available, such as annual financial reports, job descriptions, and policy statements.

Term projects with an actual business firm can be a high point. They force adult, businesslike communication and allow a student to really get inside a business. They are work but have a high payoff.

Computer games add a degree of realism by placing students in a simulated real situation giving them a feeling of "being there." It's a good teaching tool.

Case problems on actual business situations allow the student to apply principles but also teach important concepts of how businesses work internally.

Cooperative extension people often have a wealth of practical experience they can share in the classroom and are usually skilled at presenting it.

A sales experience can be highly enlightening especially since so many graduates begin their career in the selling profession. Have students select, make arrangements, and ride for a full day with a salesman.

Videotapes, films, and cassettes are widely available from business. They are professionally done and can have a dramatic impact on student learning.

Work study programs are becoming increasingly popular. These programs speak specifically to the student's needs for realism. These programs are probably the best single way to integrate the academic and the real world into a constructive experience for the student. There is just nothing quite like actual experience.

The Coop Education Program is the most thorough. This five-year program can do a good job of integrating work and study for a truly enriching educational experience while the student earns his B.S. degree. Yet it lengthens the formal education period and is costly to the administrator.

Formalized summer work experiences are also quite useful. Many larger business organizations have established programs for the junior-senior student in hopes of attracting outstanding candidates into their organization. These programs are popular and effective for students who want to taste the business world and make some money. Unfortunately, this kind of opportunity for underclassmen is still quite limited.

Informal work experiences are probably the most common as undergraduates attempt to work their way through school. The quality of the experience, however, is extremely variable. The physical labor aspect of the job is usually emphasized. Yet these opportunities

often provide a good opportunity for personal growth and learning about getting along with people of all types—an invaluable experience for students.

Promotion of the Product

As any marketing man knows, the job is not done until the product is sold profitably. The first step in this case is to prepare the student to sell himself. Career counseling must begin early to be effective. It need not be highly involved but does need to be personal and based on the values, skills, needs, and personality of the student. Although he may not be professionally trained in counseling, the students academic advisor is probably the best equipped person for career counseling since he knows the student, the profession, the curriculum, and the job market.

An important second step is giving the student direction and assistance in the interviewing process. Most students have had little or no experience in interviewing. They do not know what to expect and are a bit fearful. Group seminars on how to interview, how to make resumes, and how to evaluate employers can be very useful to seniors. Bringing in a qualified recruiter for a seminar can be a great experience for them. Letting them interview using videotape for self-analysis is also helpful.

Even though the student may be ready, he still needs contacts with potential employers. For many departments, the "senior brochure," a small booklet of resumes and photographs sent to a list of potential employers, has been very useful. Students are often contacted by firms they never thought would be interested in them or their kind of training.

Students should be encouraged to work through the campus placement office as much as possible. Yet they need to realize that agriculture is a highly personal area where the most serious recruiting is done through personal recommendations. They need to understand also that a large number of very excellent potential employers are too small to send a professional recruiter to campus and thus depend solely on personal contacts and the aggressiveness of the college graduate to find them. Faculty can facilitate this process greatly.

Faculty who are sincere in their obligation to place their students will also recognize the value of cultivating their relationships with business, will encourage open lines of communication, and will aggressively pursue opportunities for their own students. They will recognize that personality differences exist among firms as among individuals. Faculty have some idea of what kind of student might work best with a particular firm and can counsel the firm and the student into complementary arrangements. Concerned faculty will recognize the value of and need for giving honest and candid evaluations that can be relied on for accuracy.

Summary

Departments of agricultural economics are actually production-marketing organizations. Our product is human. Business concepts of marketing make it clear that careful analysis of and response to the final consumer of our product is profitable. Faculty who are in tune with the business world, use innovative tools to integrate realism into the curriculum, and concentrate on a balance of applied skills and attitudes for line jobs with conceptual and theoretical skills will find their human product in high demand.

Economic Choices between Growth, Resources, and Environmental Quality (William M. Crosswhite, Economic Research Service, Chairman)

Growth, Resources, and Environment: Some Conceptual Issues

Alan Randall

Fundamental limitations on resource availability will become increasingly important, as present and future generations attempt to satisfy their demands for goods, services, and amenities. The prognosis for the future of civilization is uncertain, but the more pessimistic predictions paint an ugly picture (Meadows et al.; Heilbroner). The production and consumption of material goods and services (MGS) and environmental amenities are subject to resource scarcity.[1] Choices must be made as to the mix of MGS and environmental amenities to be produced in any time period and the relative size of the total consumption bundle in each time period. What kinds of things will each generation consume, and how much will each generation consume relative to preceding and future generations?

Intertemporal Allocation

Let us examine first what economic theory suggests about the problem of intertemporal allocation and, second, what some fundamental laws of physics indicate. Are our economic growth models consistent with the physical laws governing the operation of our universe?

The problem of economic growth has often been analyzed as one of determining the optimal rate of capital accumulation in a world where resources are inexhaustible. The results obtained by Dorfman are typical. If social welfare is maximized in the long run by maximizing the present value of consumption over time, the rate of consumption in each time period must be chosen so that the marginal productivity of capital is equal to the sum of the social discount rate, the rate of physical deterioration of capital, and an expression representing the additional psychic cost of saving a unit of capital at the beginning of each time period rather than the end. From Dorfman's model, the optimal growth paths under many conditions approach the situation in which consumption and the capital stock grow exponentially at a rate determined by the rates of population growth and technological change. Once an optimal growth path is attained, any further growth in per capita consumption is wholly dependent on technological change. "Plateau" consumption depends on the social discount rate, higher discount rates resulting in lower steady state consumption per capita.

Turnpike models such as Dorfman's are highly unrealistic. Nevertheless, they enable identification of several key variables: the social discount rate, the rate of population growth, the rate of technological change, and the rate of physical deterioration of capital.

Solow, and Dasgupta and Heal have constructed more sophisticated models which permit the inclusion of exhaustible resources. They show that, even with the optimistic assumption that technological progress and the resource base are adequate to permit a high steady state level of consumption, the applica-

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[1] The key words in this sentence are not quite the same as those in the title. This redefinition of the topic at hand is deliberate. MGS is difficult to define with precision. However, we can include, as a first approximation, all of those items which are market goods and services (i.e., those which contribute to the gross national product). Growth is then a secular and continuous increase in the output of MGS. By focusing on the output of MGS, we place growth in its proper perspective. It is simply one of the possibilities for the future; stagnation, decline, and unstable patterns involving phases of growth, stagnation and/or decline are the other possibilities. Environment is a complex matrix of environmental amenities, which are of value to consumers although often entering GNP indirectly if at all, and resources.

tion of a positive social discount rate may result in per capita consumption tending asymptotically to zero. In other words, a society may choose eventual extinction.

Solow takes us one important step further by considering the possibility of substitution of inexhaustible inputs for exhaustible resources. His conclusion is that if the elasticity of substitution between exhaustible resources and other inputs is one or greater and if the elasticity of output with respect to reproducible capital exceeds the elasticity of output with respect to natural resources, then a constant population can maintain a constant level of per capita consumption into the very long-term future. If either of these conditions fails to be satisfied, the highest level of consumption which can be maintained into the long, long term is zero. Neither Solow nor this author can offer much empirical guidance as to the likelihood of fulfillment of these necessary conditions. However, their fulfillment in the long term will require considerable and continued human ingenuity.

The laws of thermodynamics provide knowledge about the functioning of the universe which economics cannot ignore. The second law (the entropy law) states that the entropy of a closed system continuously increases or that the order of such a system turns steadily to disorder. It indicates that our universe will inexorably "run down" or exhaust itself in the very long run, even in the absence of man's activities. The activities of man in increasing the rate of entropic degradation bring the inevitable end closer in time (Georgescu-Roegen). Thus, the long-term economic problem is best analyzed in terms of adjusting the rate of conversion of low entropy to high entropy or, perhaps more graphically, the rate of exhaustion of our universe.

The entropy law has great value in clarifying several of the issues pertinent to intertemporal allocation and growth theory. First, it places the role of technology in perspective. For the most part, technology does not expand the size of space ship earth along those dimensions that are most significant for human existence, as Ruttan (p. 708) and Schultz (p. 238) would have us believe. Rather, the technologies of the industrial and postindustrial revolutions have mostly enabled us to consume and otherwise exhaust our universe at an ever increasing rate, making massive transfers of wealth from future to present generations. However, not all technologies are equally destructive to low entropy per unit of value produced. The search for and implementation of technologies which are less destructive of low entropy would seem to be a potentially rewarding activity.

Second, this law enables us to perceive the "dichotomy" of reversible versus irreversible change as really a continuum.[2] The nonexistence of reversible change emphasizes the need for "with" and "without" project analysis and the inclusion of preservation values in project evaluation. It also provides a useful warning that recycling has inherent limits. The kind of partial recycling which is possible is not sufficient to make any exhaustible resource inexhaustible. The determination of the efficient degree of recycling is itself an economic problem.

Third, the entropy law focuses our attention on the use of flow resources as a means of increasing the value of output per unit of entropic degradation, at the same time warning us that flow resources do not quite offer a panacea in the ultimate sense.[3]

The First Law of Thermodynamics (the principle of conservation of matter-energy) is also pertinent. Since neither production nor consumption is a waste-free process (Ayres and Kneese) and since waste disposal is costless in neither money nor entropy terms, increasing consumption and/or investment increases the rate of entropic degradation by increasing the demand for low entropy for waste disposal (as well as in the ways discussed above).

Careful consideration of these two laws of thermodynamics magnifies somewhat the pessimism of the more pessimistic findings presented by the growth theorists. Our current policies emphasize the development and implementation of technologies which make us

[2] Since all change involves some entropic degradation, no change is completely reversible. However, many changes are partly reversible, i.e., they may be reversed at some finite cost or, in other words, if some finite amount of low entropy is introduced into the system. The polar cases of the continuum will seldom (irreversible) and never (reversible) be observed.

[3] The characteristics of flow resources place some limitations on their potential uses. No resource will continue to flow at an undiminished rate forever. The flow of solar energy, however, is expected to continue for a very long time. The rate of flow of a flow resource is for the most part unresponsive to man's attempts to control it. A flow resource must be used when it is provided. If not used today (or at least captured and stored), today's flow cannot be used tomorrow. Flow resources tend to flow into stocks. Thus, all of a flow cannot be used without lowering a stock. Capture of a substantial proportion of the flow of solar energy may lower the temperature of the earth. All but the most primitive production processes using flow resources seem to require the simultaneous use of some exhaustible resources.

more effective in the exhaustion of exhaustible resources and appear to be based upon a social discount rate somewhere near the opportunity cost of capital in the private sector (which is positive and relatively high). Continuation of these policies into the long term seems certain to result in Solow's case where consumption eventually declines to zero. It is left to others to estimate or guess how far in the future this will occur. However, it is not unrealistic to suggest that the intervening time may be measured in hundreds rather than millions of years.

It is useful, however, to consider the kinds of policy changes which may prolong the span of human civilization. In research and development, emphasis could be placed on finding modes of production and consumption which increase entropy efficiency. A more entropy-efficient process is simply one which produces a greater value of output per unit of entropic degradation. The use of flow resources and the development of more entropy-efficient technologies (e.g., those which reduce friction, genetic improvements in plant and animal species, etc.) are potential methods of increasing entropy efficiency. And, it seems that the maximization of the long-run welfare of the human species requires a high level of entropy efficiency.

The social rate of time preference, made effective through the social discount rate, determines the rate at which we on the one hand, invest for future generations and on the other "sell out" future generations by exhausting their universe. Further, where exhaustible resources are privately held, in the absence of policies to the contrary, the decision to hold or to extract these resources will depend on the market rate of interest, that is, the price of capital. For a private holder to continue holding, he must expect the net price of the resource (i.e., net of extraction and marketing costs) to continue growing exponentially at a rate at least equal to the rate of interest in the private sector (Hotelling, Solow).

One may express the pious, but perhaps futile, hope that some combination of altruism and survival instinct of humanity will result in some reduction of the social rate of time preference expressed in reduced social discount rates. Those who find the outcome of capital markets acceptable for the short-term allocation of capital but not for the intergenerational allocation of exhaustible resources will perhaps opt for policy solutions such as a system of graduated severance taxes, falling through time, on exhaustible resources (Solow).

Long-term solutions will require not only some adjustments in total consumption (and it should be noted that the prospects for per capita consumption can be improved by stabilizing population) but also adjustments in the consumption mix. As entropic degradation continues, it can be expected that relative scarcities will change. These changes will be reflected sooner or later in changing relative prices and/or shadow prices. Adjustments in the consumption habits of consumers will be necessitated.

Resource Allocation for the Near Future

So far, this paper has considered aggregate consumption over the long term. Now, let us consider resource allocation and the mix of goods and amenities to be produced in the short term.

The static theory of resource allocation is most instructive, not only in the conclusions it generates but also in the assumptions required to achieve those conclusions. These assumptions can be interpreted as warnings as to how real world outcomes might vary from the theoretical optimum. If actual distributions of income, wealth, legal rights, etc., coincide with the distributional preferences of society, if all rights are nonattenuated,[4] and if all of the requirements of pure competition are satisfied, unfettered markets will result in socially optimal production and consumption patterns, given resource scarcity and the existing tastes and preferences of the participants in those markets.

It would be an arduous task to compile an unabridged compendium of the ways in which the essential conditions are violated in the real world. However, some violations which are especially pertinent to the resource issue will be enumerated below.

There is no evidence that the distributional variables are coincident with social preferences. Resource markets, particularly in energy and mineral resources are especially susceptible to noncompetitive influences. International cartels of resource-exporting nations have arisen. Corporate oligopoly is no longer confined to individual resources, and energy conglomerates threaten to modify sub-

[4] This means fully specified, rigidly enforced, exclusive, transferable, and in no way inconsistent with the marginal equalities necessary for efficiency.

stitution patterns by changing long-established price cross elasticities on the supply side. Attenuation of property rights is not unknown in the markets for MGS and seems almost the rule rather than the exception in markets for environmental amenities.

Economists, led by Ayres and Kneese, have rediscovered the First Law of Thermodynamics. The myths of waste-free production and total consumption have been exploded. Waste disposal is an integral part of production and consumption processes. In effect, the production and consumption of MGS tends to use environmental resources and reduce the flow of environmental amenities.

Where the expense of waste disposal is external to the private economic calculations of producers and consumers, externality is pervasive rather than unusual and empirically insignificant. Without corrective social action in the form of regulation, price modification, or redefinition of property rights, the market will underprovide environmental amenities.[5] The problem is broader than indicated by the more restrictive definitions of externality in that environmental resources are often of the common property variety and environmental amenities are often public goods. Attenuation of property rights often results from government action, particularly in the regulatory field. Thus, government is a major contributor to the list of market imperfections.

Even in the absence of the kinds of market imperfections discussed above, some serious adjustment problems would face our society in the near term. The changes in relative scarcity and prices which we are now experiencing are not entirely due to market imperfections. The immense production of MGS in aggregate and the particular kinds of MGS we are producing (i.e., kinds which are often highly destructive of low entropy) suggest that depletion of at least some resources is well under way. Thus, some relative and absolute changes can be expected in resource prices, necessitating adjustments in consumption habits.

Sharp changes in the patterns of relative and absolute scarcity are likely to have major distributional consequences. Thus, it is important to assure that the costs of dislocation and adjustment are not borne disproportionately by the poor. The short-term needs, in the most general terms, are for policies aimed at promoting distributional justice, promoting competitive structures (or structures which perform in the manner of competitive structures) in resource markets, eliminating, to the extent possible, market imperfections attributable to attenuated structures of property rights,[6] and assisting, or at least not impeding, the process of market adjustment to changing relative scarcity.

Reconciling the Immediate and Long-Term Solutions

The long-run outcome will be largely the result of a long sequence of short-term policy decisions to solve short-term problems or "crises," as we typically call them. However, I have serious reservations about some of the policy directions in which our crisis mentality seems to be leading us.

If it can be agreed that the long-term problem can best be attacked by the reduction of prevailing rates of time preference, the development and use of entropy-efficient technologies and flow resources, and the adjustment of consumption habits to the emerging realities of scarcity, then the policy question, in simplistic but nevertheless useful terms, is to find ways to make the necessary adjustments without causing excessive dislocations and demanding excessive sacrifices from present generations. Policies for the near future must start us moving in directions compatible with and contributory to the long-term solution.

Economists are long accustomed to using prices as the best indicators of the interactions of scarcity and consumer demands. However, in analyses designed to identify long-run solutions, the uncritical use of existing prices is dangerous for the reasons discussed below (in addition to those suggested by market imperfections). Crucial prices can be expected to change drastically as our uncertain future unfolds. Technological developments will change cost ratios in production while future demands of MGS and environmental amenities are most uncertain. Human values are fundamental to utility functions, which are fundamental to the price ratios of goods, services, and amenities. Yet value systems can be expected to change, as a result of propaganda, in accommodation to new views of reality (we are already seeing some of this reflected, for example, in the market for automobiles), and in other ways not

[5] The author prefers this latter approach to the extent that it is feasible. He is aware of some of the limits to its feasibility.

[6] This implies elimination or modification of many existing public policy and regulatory instruments.

well understood. And if, as some believe, the present value system of our culture is incompatible with the long-term survival of our civilization, the process of changing value systems might fruitfully be encouraged. All of this provides a warning that the implementation of solutions (particularly those involving massive and perhaps publicly subsidized capital investment) based on current prices may perpetuate our problems by delaying essential adjustments in technology and human demands.

These considerations suggest that research to identify and evaluate policy solutions must incorporate materials flow analysis and energy budgeting (better yet, entropy budgeting, if techniques can be made applicable) into economic analyses.[7] Energy budgeting, for example, is potentially helpful in providing early warning of coming changes in scarcity and price relationships.

One suspects that some of our current policies are quite myopic, viewed from the perspective suggested above. Policies aimed at simply substituting somewhat less scarce fossil fuels for the very scarce ones may fall in that category. It is easy to see why coal gasification and liquefaction are receiving encouragement: the final products are compatible with existing systems for distribution, marketing, and end use. In that sense, the process of short-term adjustment to scarcity of oil and natural gas is eased. Yet, supplies of coal will not last forever and in the interim preceding exhaustion (a period of perhaps no more than a few hundred years, at current rates of use), expanded rates of extraction will come at increasing costs in terms of both money and environmental amenities.[8] Nuclear energy production based on breeder reactor technology would enable us to utilize an exhaustible resource which is expected to last hundreds and possibly thousands of years. However, future generations would be left with the burden of the perpetual care of plutonium, which is both extremely toxic and a prime weapon material (Krutilla and Page). Shale oil appears to be available in large quantities, but its extraction appears to be both environmentally devastating and of relatively low energy efficiency (i.e., the amount of energy used in extraction approaches the amount produced).

One wonders why flow sources of energy, the sun, the winds, and even the tides, have received research and development expenditures which are only a small fraction of those devoted to these exhaustible resources. One answer may lie in the area of property rights. Private sector entrepreneurs could expect to capture the patents to technologies they develop but not the ownership rights to the resources whose value is suddenly increased. Regardless of any institutional reasons for our current low level of effort in developing flow energy sources, one suggestion emanating from the logic developed herein is that more effort should be made.

These arguments are not intended to deny the need for continued exploitation of exhaustible resources. That is essential, if for no other reason, to ease the burdens of adjustment placed on present generations. However, a shift in emphasis toward utilization of flow resources seems called for, starting immediately.[9]

One may also be critical of policies which seem aimed at slowing the adjustments of consumers to the emerging realities. Continued and substantial public expenditure on highway development is one example. It seems that adjustments in the use of petroleum products (not only as energy sources, but also in the production of a wide range of goods including pesticides, fertilizers, and plastics) must be made eventually, if not immediately.[10]

There are indications that it is current policy to allow the underprovision of environmental amenities in general (occurring in the first instance as a result of pricing problems in externality and public goods situations) relative to MGS to continue.[11] Even if this is consistent with current voter preferences (and I do not concede that it is), it seems inconsistent with any acceptable long-run solution.

The above comments are directed primarily at American society, yet an international perspective is also essential. Population pres-

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[7] Energy budgeting alone, however, is also misleading. Some forms of energy and low entropy can be used more cost-effectively than others. Outputs are not all of equal value.

[8] There is another, short-term reason to be wary of immense investments in coal conversion. The current price of oil contains a large element of monopoly profit which could be reduced at will. Oil substitutes produced from coal could overnight become the higher cost alternative.

[9] A major problem facing the policy analyst is the scheduling of the depletion of each exhaustible resource and the implementation of technologies to bring flow resources on line. The risk averse will apply the principle "better too soon than too late" to the latter.

[10] The monopoly element in current petroleum prices makes all policy pronouncements subject to revision on short notice.

[11] On the other hand, particular goals proposed by public agencies (e.g., "zero discharge" into the nation's waterways) go beyond the efficient level of internalization and, if doggedly pursued, would result in overprovision of some kinds of environmental amenities.

sures, if unchecked, combined with the traditional use of less developed countries as suppliers of raw materials (often exhaustible resources) to more prosperous countries, seem to guarantee that per capita consumption in many of the LDCs will not rise to the levels enjoyed in western Europe and North America.[12] This suggests the need for stringent population control in many LDCs. It may even be desirable to encourage this process by offering some international redistribution of income and wealth as a quid pro quo.

In the more prosperous nations, population growth seems to be slowing down. Considering, particularly, the impact of population in reducing the level of environmental amenities, it seems there is nothing to gain from a reversal of this trend.

Concluding Comments

The doomsday predictions, perhaps typified by the Club of Rome report (Meadows et al.), seem to have been largely discounted. However, there is no serious disagreement that, if the world economy were to maintain its present course, disaster would strike in a relatively few years. On the contrary, the prevailing argument is that the doomsday theorists have grossly underestimated the human ability to make adjustments in technology, resource substitution, and consumption habits.

Even the so-called "optimistic" studies such as the Ridker report amplify the need for such adjustments.[13] Public policy must be directed at encouraging the essential adjustments without placing excessive burdens on present generations. Some directions for public policy can be suggested.

The rate of resource exhaustion and, more generally, entropic degradation, which has been increasing apace, must be decreased. Appropriate policies include the reduction of the social rate of time preference; a system of graduated severance taxes, falling through time, on exhaustible resources; a conscious policy of risk aversion where disastrous outcomes reversible at great expense, if at all, are possible; and conscious efforts to control population growth. The development and implementation of technologies to use flow resources should be encouraged through ingenious modifications of the system of property rights and direct public investment, to the extent that efforts through the former route fall short of achieving the goal. Efforts to end the systematic underprovision of environmental amenities (resulting from market imperfections), begun in earnest in the first few years of the current decade, should be continued without interruption.[14] Increasing scarcity (perhaps with the exception of that attributable to monopoly influences) should be allowed to be reflected in market prices. Sudden, shocking, and perverse distributional consequences should be alleviated through lump sum transfers.

No policy can repeal the entropy law. However, the kinds of policies suggested above will allow us to live with that law as best we can, and that seems eminently desirable.

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[12] The exceptions occur where it is possible to extract huge monopoly rents on raw materials for a long and continuing period (as the OPEC nations have done for few years, as of now). At any rate, "if the whole world developed to American standards overnight, we would run out of everything in less than 10 years" (Boulding, p. 166).

[13] Ridker estimates that resource scarcity will cause few severe shortages in America during the next thirty to fifty years. However, his definitions and assumptions suggest some cause for concern: Severe shortage is defined as a situation leading to a relative price increase of 50% or greater for any raw material. Thus, Ridker's conclusion could be consistent with sharp relative price increases for many resources. That study assumes continued technological progress and resource substitution, and continued unimpeded imports of raw materials. The possible impacts of increased monopoly influences and rising resource demands in the rest of the world are ignored. Thus, it is possible to read Ridker's "optimistic" study as suggesting less than unrestrained optimism.

[14] And, perhaps, efforts should be redirected toward making fuller use of the inherent efficiencies of the market system. Total reliance on the market, however, would be naive.

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Scarcity and Growth: How Does It Look Today?

Richard B. Norgaard

Twelve years ago, in a book entitled *Scarcity and Growth,* Barnett and Morse demonstrated that the labor and capital required to extract most resources had declined strikingly since 1870. The economics profession, intent at the time on accelerating our economy faster than competing socialist models, cited this analysis when asked why Keynesian systems were constructed without natural resource constraints. The continued existence of New Frontiers was a supposition of both political oratory and economic theory.

We are neither so naive nor confident today. The environmental crisis, the Arab oil embargo, and the subsequent reanalyses of our resources, technologies, and institutions have swept us over an awareness threshold toward the "economics of the coming spaceship earth" (Boulding). Our pessimism, however, probably stems from our having accepted other realities—that we have not succeeded to eliminate domestic poverty, to globally spread democracy and capitalism, and to grapple with environmental dilemmas. For example, we are far more aware today than a decade ago that environmental interrelationships are numerous, sensitive, and largely unknown. Yet, we have not developed satisfactory methods of adjusting our actions in light of this now widespread consciousness. Consequently, we have become prudently skeptical of our ability to safely manage extensive, incompletely understood systems. This skepticism fuels the rising attack on the breeder reactor program in particular and labyrinthian technologies in general (Kneese). To relieve our doubts, we are allocating more resources to environmental impact analysis, land-use planning, technology assessment, and research and development diversification—in short, to thinking ahead. Small, stable systems are increasingly being perceived as beautiful (Schumacher). In summary, our concern over scarcity and growth today is based on the long-standing issue as to whether we are developing technologies as fast as we are depleting high-grade resources. But our perception of this race is more sophisticated due to our increased awareness of the inevitable, the potential, and the sometimes irreversible environmental and social consequences of rushing ahead.

Economists are giving extensive thought to resource scarcity for the first time since classical economists defined the issues. Contributions are being made in three areas: empirical analysis of the race between technology and resources, extensions of the Hotelling model of stock resource allocation over time, and the application of natural laws to economic systems.

Nordhaus (1974) compared the relative prices of minerals to labor between 1900 and 1970 and concluded that the historic decline in resource extraction costs analyzed by Barnett and Morse continued through the 1960's. Brown and Field, in an exploratory paper on alternative definitions of resource scarcity, illustrate that the prices of many resources have increased over time relative to the prices of quality-adjusted capital and labor. New technology offset only 73% of the increased costs due to resource scarcity in U.S. petroleum development between 1939 and 1968 (Norgaard). These studies help document past developments in the race between technology and resources but have yet to help clarify our more recent, broader concerns for the future.

Many economists have developed a new interest in models of stock resource allocation over time. Models such as Hotelling's have been further developed; and the impacts of alternative market structures, taxation schemes, and technological and resource conditions have been analyzed (Peterson; Dasgupta and Heal; Nordhaus 1973). Dasgupta and Stiglitz have begun to examine market structure and innovation strategy under uncertainty. In addition, optimal growth models have been modified to include stock re-

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sources, flow resources, technological change, and population growth (Ingham and Simmons; Stiglitz). Theory has progressed at the rapid rate one would expect in an area long ignored. We can look forward to significant policy implications when both social risk aversion and opportunities to reduce risk through exploration, research, and resource diversification are incorporated in these models.

Further elaboration of the above two deficiencies provides an appropriate transition to the remainder of this paper. Society's major concern over resource scarcity today is not so much that there is too little but that our resources and technologies are uncertain. We do not know whether there are three or thirty years worth of oil on the outer continental shelf, whether we can utilize oil shale with tolerable environmental side effects, or whether we can develop acceptable institutions to prevent plutonium diversion from breeder reactors. This uncertainty, in turn, can be reduced by gathering information through exploration, research and development on diverse energy sources and conservation techniques, and environmental and social assessment.

Except for Ciriacy-Wantrup (especially chap. 18), few economists have considered the concept of social risk per se. In the definitive article on why uncertainty can be ignored by public decision makers, Arrow and Lind carefully delineate the limits of their argument (p. 373). Social risk must be considered when a collection of interdependent public decisions has a large influence on welfare directly attributable to the public sector. Further, social risk is even more likely to be important if the covariance between these decisions and national income generated in the private sector is also large and positive. Even assuming risk neutrality, Arrow and Fisher have shown that irreversible uncertain decisions should be discounted for risk when further information will be available in the future (see, also, Henry). The myriad of decisions with respect to energy research and development, exploration, leasing, taxation, import controls, power plant siting, pollution control, and efficiency standards now loom large in the public sector. The strong correlation between energy availability and income generated in the private sector was experienced during the oil embargo. An economic model which incorporates social risk aversion, interdependent decisions, and the opportunity to reduce uncertainty through information collection could be fruitfully applied to public sector decisions with respect to resource allocation over time.

Several economists have made interesting beginnings at applying natural laws to economic systems (Daly; Georgescu-Roegen; Kneese, Ayers, and d'Arge). Considerable conceptual difficulties are hindering the development of a new paradigm. Nevertheless, Daly and others argue that some sort of a steady state system relying largely on flow resources would both reduce many environmental and social problems and be viable over the long run. An invigorating, productive debate has not developed largely because economists have ignored or put down the challenge.

An Economic Model of Planning Ahead

Historically, new technologies and the exploitation of new resources or ecological relationships were initiated freely. Under this state of the law, many impacts—especially external effects resulting from changes—were discovered through experience. Bad experiences have become increasingly common as we use our resources more fully and as our technologies become more pervasive. Consequently, society increasingly constrains initiators through legislation requiring research and information dissemination with respect to all conceivable impacts of proposed changes. The following model provides a framework for describing this observed historical transition in our social institutions from a system of learning from experience to a system of planning ahead. The term "planning" has many connotations to economists. This paper is concerned with only information-gathering activities and, further, with only those undertaken for the purpose of reducing the likelihood of making mistakes today which affect future welfare. The development of more productive technologies is an aspect of planning ahead which is not considered due to space limitations. Some planning ahead has always occurred, but today we are experiencing a dramatic increase in the form of environmental impact assessment, technology forecasting, land-use planning, and applied research diversification. The model rationalizes or explains this transition; no prescriptions, however, stem from this approach.

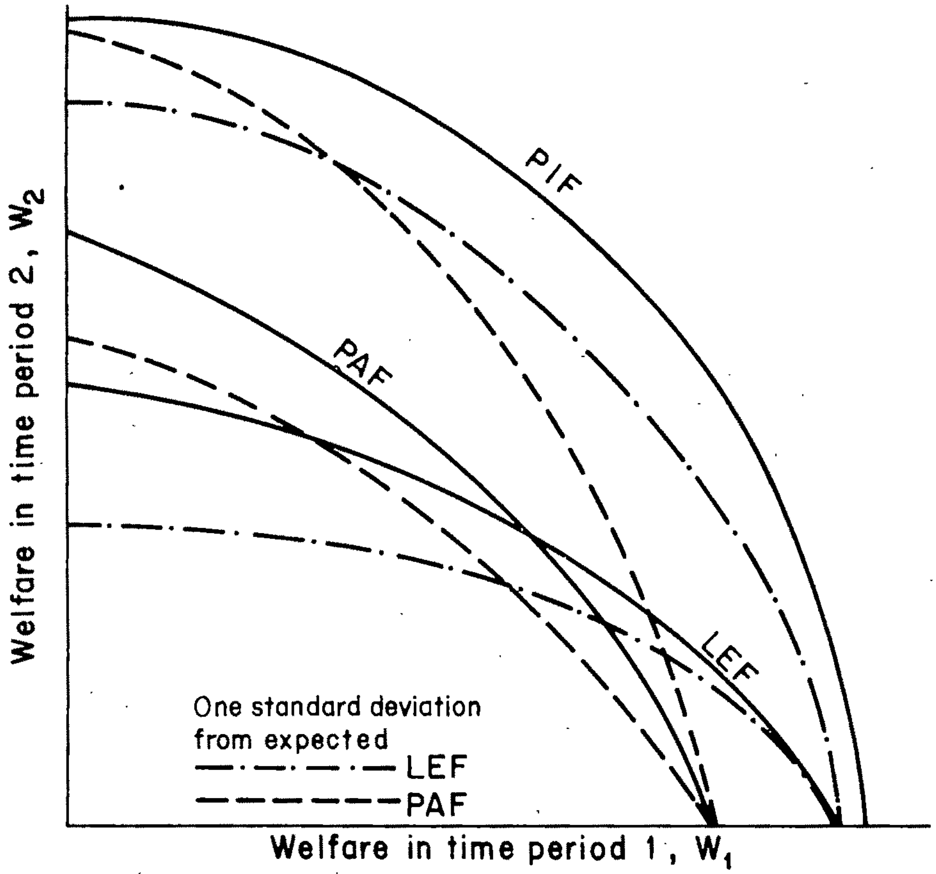

Figure 1. Alternative consumption possibility frontiers

The trade-off between welfare in time periods 1 and 2 under the conventional assumption of perfect information is represented by the frontier labeled PIF (fig. 1). Given imperfect information, society chooses between two institutional frameworks, learning from experience represented by the frontier labeled LEF or planning ahead represented by PAF. Welfare in time period 2 is uncertain under each strategy as indicated by the dotted lines bordering LEF and the broken lines bordering PAF which represent one standard deviation from the respective expected values. The solid frontiers shown are less than the expected values (less than midway between the standard deviation) because of risk discounting. The risk-discounted frontiers of the two strategies intersect because planning ahead utilizes resources in time period 1 which do not contribute to welfare in time period 1 and because learning from experience has more uncertainty resulting in more risk discounting for time period 2. Historically, society has been on the LEF frontier because that frontier has had a tangency with a higher welfare social indifference curve (SIC) than the PAF frontier (not illustrated for clarity).

A comparative static view is attained by comparing subsequent choices. Figure 2 illustrates an initial situation in which society is indifferent between the two strategies. Relative to the learning from experience optimum at point A, less welfare in the present and more in the future is preferred at the planning ahead optimum at point B. The slope of the social indifference curve indicates society's time preference. It is interesting to note that the rate of interest—the slope of both the frontier and the SIC at the tangency—is greater at the PAF optimum than the LEF optimum, indicating that after planning ahead both the perceived returns from and willingness to forego consumption in the present are greater. LEF′ and PAF′ represent frontiers for two subsequent time periods. New technology has apparently improved the lot of mankind since these curves are generally above and to the right of the previous set. The shift to the right,

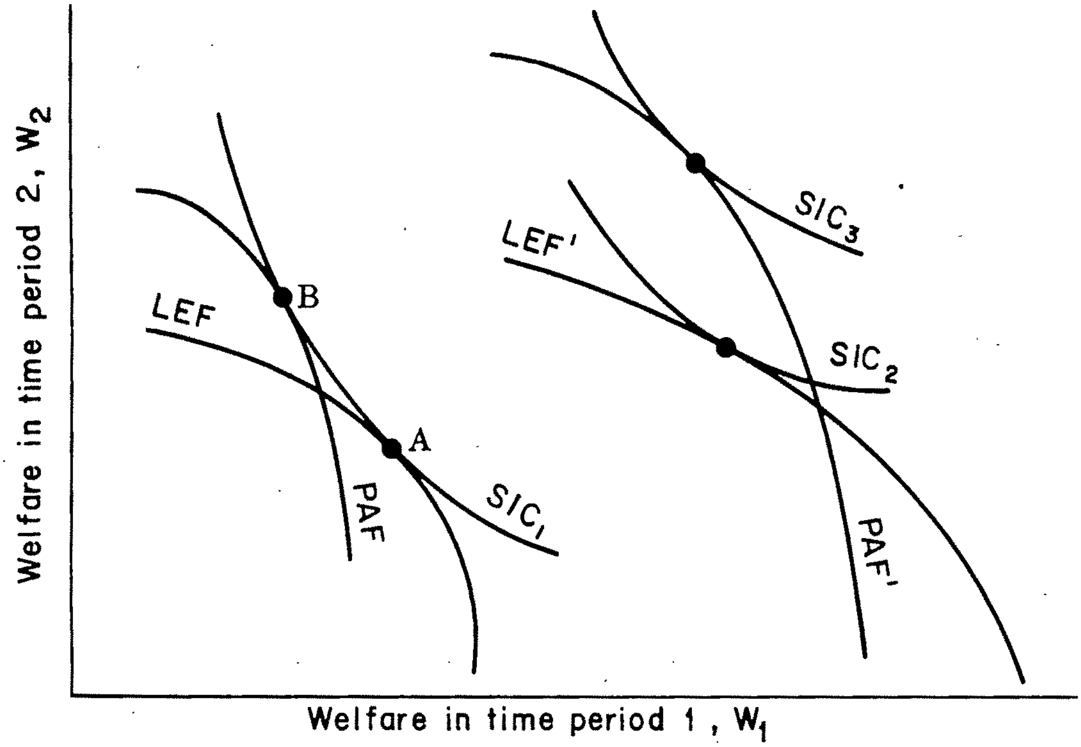

Figure 2. Technological change more than offsetting resource scarcity

however, is greater than the shift up because the uncertainty of resources and technologies is greater than before. As drawn, society now definitely prefers to plan ahead due to its risk aversion.

Fortunately, the conditions leading to the transition between learning from experience to planning ahead can be stated more formally. Norgaard and Hall developed an analogous model to describe the conditions under which society would switch from a legal structure in which polluters have the right to pollute and must be compensated to prevent pollution to a legal structure in which pollutees have the right to a clean environment and must be compensated for their toleration of pollution. Using constant elasticity of transformation frontiers, we know from this earlier work that technological change over time that increases in uncertainty in the future time period results in an interesting phenomenon. The intersection between the LEF and the PAF frontiers falls toward the W_1 axis such that the PAF frontier encompasses increasingly more of the LEF frontier. This occurs regardless of whether technology outraces resource scarcity. If society prefers to consume between the two periods in fixed proportions (W_1 and W_2 being perfect complements resulting in a constant rate of planned growth or decline), then eventually planning ahead will be preferred (Norgaard and Hall, pp. 255–56 and appendix).

Planning ahead will also eventually be preferred under less restrictive assumptions. Smith, in a related model of technological change, juxtaposed constant elasticity of substitution indifference curves with constant elasticity of transformation consumption possibility frontiers. Extending this approach, the results of Norgaard and Hall indicate that planning ahead will eventually be preferred as long as the elasticity of substitution between welfare in the two time periods is between 0 and 1 (pp. 257–58 and appendix). Within this range the social indifference curves neither cross nor become asymptotic to the axes indicating that some positive level of welfare in each period is preferred and that, eventually, further increases in total welfare are not possible without increases in both periods. These characteristics appear to be consistent with our observed preference for a future existence.

In conclusion, though analysis is only in the formative stage, it appears that the model can

be generalized. Intermediate strategies or more or less planning ahead could be considered rather than the two extreme cases analyzed. Given an elasticity of substitution less than one, we can expect incrementally more planning ahead to be preferred over time as the uncertainty of resources and technology with a growing population increases. This model rationalizes the observed transition toward planning ahead. No conclusions can be drawn, however, as to whether we are actually doing too much too soon or too little too late to coordinate resource use and environmental management over time.

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Balancing Environmental Quality, Energy Use, and Growth: Difficult Decisions

Fred H. Abel

Society's decision makers are concerned with providing the maximum quality of life for its members. A major task is determining the factors that contribute to improved quality of life. Since there are many factors, a second task is determining the correct balance of these factors. Society seems to change the factors or their relative importance rapidly; witness the shift from civil rights to poverty to peace to environment and now to energy self-sufficiency. Currently, three major issues seem to be environmental quality, economic growth, and energy self-sufficiency. The problem of the correct framework for balancing these factors, results of quantifying some of them, and present methods for trade-off analysis are briefly examined.

Historically, most societies have chosen to maximize economic growth under the assumption that this leads to increases in the quality of life. This assumption is being challenged by some who argue that economic growth is not necessarily good and others (Daly) who argue that it is necessarily bad because it uses too many scarce resources (that are presumably underpriced in the market) and damages the environment (which is generally not priced at all). Thus, we seem to have a new set of objectives: to maximize economic growth subject to the constraints of not using too many scarce resources and not doing too much damage to the environment. The problem is deciding how many resources are too many and how much environmental damage is too much.

As analysts and economists, we would like to solve this problem for the decision maker by developing empirical estimates of a net social welfare or quality of life objective function, including quantification of all major variables (preferably in economic terms) and estimates of their correct weights (coefficients).

If the major factors affecting net welfare cannot be quantified in a single function, analysis must deal with subobjective functions. For example, environmental quality or energy self-sufficiency become independent objective functions. Comprehensive analysis thus must show the level of each subobjective which are then compared in some kind of trade-off analysis. The degree of quantification of any of the factors depends upon the state of the art of quantification techniques and the needs of the decision maker. The second part is important, as I have discovered that even though we can value both premature death and ill health in economic terms, decision makers reject them preferring only the number of adverse health effects.

For our purposes, it is clear that today the subobjectives of becoming energy self-sufficient, continuing economic growth, preserving or improving the environment, and the trade-offs involved are among those of principal concern. It appears that if we try to obtain any one, our ability to obtain the others is reduced so real trade-offs are involved. But what is really being traded, that is, how are environmental quality, economic growth, and energy self-sufficiency quantified?

I will restrict my comments on quantification to environmental quality as quantification of energy and gross national product is better understood. Concern for environment quality is really a concern about how poor or deteriorating environmental quality affects the quality of life. It affects the quality of life by causing ill health, premature death, and reduced property values, as well as by increasing the costs of avoiding the pollution, the cost of good recreation, and the psychic costs (i.e., the mental discomfort occasioned by the real-

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The views presented are those of the author and are not necessarily those of the Energy Research and Development Administration or the Environmental Protection Agency. Any mistakes in the paper are the author's, but special thanks go to Michael Hay and Dennis Tihansky who assisted with this paper.

ization that nature is being violated, that there is increased risk of environmental catastrophies, and that some environmental use options are lost to us and to future generations).

While environmental quality as a whole is not directly quantifiable, some attempts have been made to derive indexes of environmental quality (CEQ 1972). However, for the most part these indexes have not been accepted as measures of environmental quality. Instead, measures of either ambient quality of air and water or residuals discharged to the environment are used as measures. Neither relate directly to pollution costs (damages) and that is what really matters. A better alternative is to estimate environmental damages caused by pollution.

The magnitude of these costs (damages) are difficult to quantify as they vary with geographic location, peoples' perceptions of what ought to be, and economic conditions to the extent that it changes the value of these items and peoples' willingness to pay to avoid them. Nevertheless, the best economic measure of changes in environmental quality is the value of all these costs.

Estimates of national costs (damages) of air and water pollution in 1973 are presented in table 1. Damage from air pollution is $20 billion with aesthetics and health the major damaged categories. Damage from water pollution is $11 billion with recreation accounting for 60% of the total. The annual pollution costs of $31 billion give us some idea of the magnitude of the pollution problem. These are not benefits of pollution control expenditures to date but rather are the benefits to be obtained by completely cleaning up the remaining air and water pollution. Current benefits would be the difference between the above pollution costs and what the pollution costs would be in the absence of any control program. This value has not been estimated.

Table 1. National Costs of Air and Water Pollution, 1973

Damage Category	Best Estimate ($ billion)	Range Low ($ billion)	Range High ($ billion)
Air			
Health	5.7	2.0	9.4
Aesthetic	9.7	5.7	13.7
Vegetation	2.9	1.0	9.6
Materials	1.9	0.8	2.7
	20.2	9.5	35.4
Water			
Human health	0.64	0.32	0.97
Psychic	1.49	0.65	2.76
Outdoor recreation	6.32	2.51	12.60
Materials damage	0.77	0.35	1.11
Productions costs	0.72	0.14	1.40
Property value	0.08[a]	0.03[a]	0.18[a]
	10.66	5.45	15.52
Total air and water	30.86	14.95	50.92

Sources: Abel, Tihansky, and Walsh. *Water Pollution;* U.S. EPA, *Costs of Clean Air.*
[a] Not included in total.

It has been estimated that annual cost of air and water pollution control in 1973 was $5.7 billion and if standards are met, it will be $26.3 billion in 1982 (CEQ 1974). A single cost-benefit analysis of the above numbers suggest that if all of the potential benefits were realized by accomplishing the standards, then by the 1980s the annual benefits would exceed the annual control costs. If we accept these values and ignore the distribution effects, we still cannot conclude that the environmental program is worthwhile. What has not been included in the benefit-cost analysis are the effects of the program on energy self-sufficiency and economic growth.

An analysis of the impact of the environmental program on economic growth was performed by the Council on Environmental Quality (1975). The Council, using the Chase econometric model, estimated that the impact of environmental control expenditures through 1976 will increase economic growth above what it would be otherwise. In 1975, GNP would be 1.6% higher. Then during the late 1970s economic growth would be depressed. The real GNP was projected to be depressed by 2.0% in 1979 but by 1982 real GNP moves back to the baseline. In other words, according to the model, the impact of pollution control expenditures on economic growth is to increase it for a few years, then depress it, and then to have no affect after about 1982.

I don't believe the Chase model is accurately projecting the adverse impacts of the environmental programs on GNP. What is missed is the loss of goods and services because new economic activity, particularly the construction of new energy facilities, did not take place or has been delayed. According to the Chase model, by 1982 an improved environment would be a free lunch. I would like to believe that, but I don't.

The Chase model did not include the impacts on energy self-sufficiency nor did it de-

termine what environmental benefits are obtained. Although there is a large number of models estimating or simulating economic growth, evironmental costs, and impacts of energy use, none simultaneously analyzes the trade-offs among the three.

One model that has promise for predicting the trade-off is the Strategic Environmental Assessment System (SEAS) developed by the Environmental Protection Agency. The system combines fourteen computer models. The principal one is the Almond interindustry model. This is augmented by adding about 300 subsectors for the Almond sectors that have strong environmental problems. Economic growth rates, productivity, aggregate demand, and rates of substitution of new cleaner technology for old are inputs, and outputs are energy consumption, emissions of forty pollutants, GNP, unemployment, output, transportation, and investment in plant and equipment. The estimates are for each year through 1985 and can be obtained for counties, states, and regions. With many runs, one can determine for different growth and productivity rates and with or without abatement activity the impact on pollution and energy use.

Some selected preliminary results are presented in table 2. The preliminary results suggest that abatement activity decreases unemployment, increases energy demanded, and greatly reduces some pollutants. The low economic growth rate greatly reduces the demand for energy.

Although this and all simulation models can show the effect of selected changes on key factors, they do not determine if such changes are good or bad. For example, is the great reduction in emissions worth the use of so much additional energy? Of course models can never determine if these trade-offs are worthwhile; only decision makers can. However, models can be very useful in estimating the magnitude of the trade-offs.

In summary, there does not exist an adequate framework for analyzing the tradeoff between energy self-sufficiency, environmental quality, and economic growth. A single quality of life or net social welfare function cannot be estimated. Even if it could, it would have to be re-estimated frequently as the relative importance of the factors change. Trade-off analysis where the level of all major factors are estimated for each policy option is the only realistic method of analysis. In this analysis major factors can be quantified in different units and even important factors that cannot be quantified can be included. Unfortunately, this leaves the decision maker with the job of comparing noncommensurables. For factors like energy self-sufficiency, environmental quality, and economic growth, this is a major task.

Progress has been made in quantifying environmental damages and control costs. However, only very imprecise national cost-benefit analysis can be performed. The improved techniques can lead to estimates of marginal

Table 2. Selected 1985 Results of Preliminary Runs of the Strategic Environmental Assessment System (SEAS)

	Scenario[b]				
Outputs[a]	1	2	3	4	5
GNP (T 1971$)	1.80	1.80	1.59	1.59	1.81
Unemployment (%)	4.4	4.1	4.3	4.1	4.3
Output (T 1971$)	3.10	3.11	2.74	2.76	3.10
Equipment investment (B 1971$)	161	161	139	140	159
Construction (B 1971$)	130	130	113	113	129
Passenger transportation (T miles)	3.62	3.60	3.02	3.01	3.62
Freight transport (T miles)	3.52	3.57	3.19	3.24	3.69
Recycled aluminum (M tons)	2.22	2.22	2.06	2.06	2.16
Btu. (quads)	109	113	95	106	103
Air particulates (M tons)	35.7	3.67	32.3	3.27	35.6
Nitrogen oxides (M tons)	29.9	27.3	26.4	24.4	28.9
Sulphur oxides (M tons)	52.9	20.3	47.8	18.4	51.1
Biochemical oxygen demand (M tons)	4.90	1.23	4.41	1.14	4.86
Total suspended solids (M tons)	18.4	1.21	16.6	1.14	18.27

[a] T = trillion, M = million, B = billion, quads = quadrillion.

[b] Scenarios: 1—High growth rate, high productivity, no additional abatement; 2—high growth, high productivity, abatement; 3—low growth, low productivity, no additional abatement; 4—low growth, low productivity, and abatement; 5—high growth, high productivity, and energy conservation (gross savings of 15 quads).

costs and marginal benefits which are required in trade-off analysis.

A promising method for complex trade-off analysis is a simulation model like SEAS, although there are currently no models that can do this. Even so, econometric models can handle trade-off among economic factors like pollution control expenditures and GNP, but cannot handle nonquantifiable factors like environmental quality, energy self-sufficiency, or quality of life. Although quality of life is the ultimate objective function, it will never be quantified. The major factors in quality of life are love and friendship and they will never be captured for quantitative analysis.

Decision makers choosing the correct level of energy self-sufficiency, economic growth, and environmental quality cannot depend upon the econometric or simulation models in the near future; the framework, techniques of quantification, and method of analysis simply aren't available. Economists must concentrate first on developing an integrated analytic framework that recognizes that many of the factors important to quality of life are not included in GNP. For example, economic efficiency requires that all pollution be controlled and the costs included in product prices; then consumers will determine the optimum in the market place. But, consumers could obtain a higher quality of life if they could select some mix of environmental degradation which they would be willing to live with and some increase in product prices because of pollution control. Second, economists must develop tools and quantification techniques that allow systematic comprehensive trade-off analysis. Even with this, these difficult decisions will remain difficult but perhaps less so.

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Implications of Energy and Environment upon Growth in the Food and Fiber Sector

Theo F. Moriak

This paper synthesizes information on the effects of environmental restraints and increased energy costs on prices and quantities in the food and fiber sector. It looks at how direct impacts on one commodity lead to subsequent impacts on other commodities, resulting in a synergistic effect. The data measuring these effects are analyzed with the assistance of POLYSIM which utilizes elasticities to estimate deviations from a baseline scenario of crop and livestock variables at the farm production level (Ray and Moriak).

Processing, transportation, and distribution components of the food and fiber sector also have important and perhaps critical environmental and energy-related pressures on retail prices. However, this paper does not treat those components of the food and fiber system. Neither does the paper indicate the long-term possibilities of overcoming environmental restraints and increasing energy costs.

Environmental Impacts

Environmental impact studies have been done for a large number of potentially contaminant agents affecting food and fiber. These studies usually were applied to a specific commodity in a given location. The studies showed little national impact.

The herbicides and pesticides affecting major crops considered here are 2,4-D, aldrin, 2,4,5-T, and chlordane. Restricting 2,4-D, used in weed control, would have noticeable repercussions on U.S. yields for feed grains and wheat (Fox et al. 1971). The result of restricting aldrin on corn yields would be minimal (Delvo). Efforts to offset the negative effects of these chemical restrictions would increase variable costs. Alternatives to 2,4-D on feed grains would noticeably affect variable costs per acre (Fox et al. 1971). The cost impacts of aldrin, 2,4,5-T, and chlordane would be small for feed grains and wheat (Delvo, Fox et al. 1971, Jenkins). The upper left side of table 1 shows the nationally accumulated impacts on yield and variable production costs from restricting these items.

The environmental impacts on livestock feed efficiency and costs are due to DES and other antibiotics at subtherapeutic levels, wastewater runoff, and lindane. DES and other antibiotics are routinely used in minute amounts for increased growth and reduced mortality in beef cattle and hogs. Their limitation could decrease feed efficiency. The change in variable costs, other than feed, due to their limitation would be small (Gilliam et al.). Reducing waste-water runoff from concentrated feeding operations would have tremendous cost impacts on small producers; however, current regulations apply only to large producers—1,000 beef animals, 2,500 hogs, and 700 dairy cows. Estimates on nonfeed variable costs, in the lower left of table 1, would be more nearly representative of 50–60 cow dairy herds and 200–300 hogs (U.S. Congress, House).

Energy Impacts

Estimating energy consequences on costs in agriculture is complex and there is a great deal of confusion regarding appropriate comparisons. Some use kilocalorie output/kilocalorie of fossil fuel input to show the declining efficiency of transformation. Aggregating alternative energy sources is hazardous. They are measured in different units. Some energy is portable, some requires expensive fixed cost equipment, and other kinds are difficult to

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Table 1. Working Estimates of the Impacts on Output per Unit of Input and Costs Due to Environmental Restraints and Energy-Related Cost Increases

	Environmental Restraints[a]	Energy-related Costs[b]
	%	
Output/acre:		
Feed grain	−2.74	
Wheat	−4.05	
Variable costs:		
Feed grain	4.15	10.8
Wheat	0.72	8.24
Soybeans	—	7.48
Cotton	—	10.7
Output/feed:		
Beef	−1.6	
Hogs	−1.8	
Nonfeed variable costs:		
Beef	3.03	0.54–2.88
Hogs	5.5	1.46–2.66
Sheep	0.18	1.10–1.62
Broilers	—	0.96–3.10
Turkeys	1.5	1.02–3.90
Eggs	—	0.52–1.56
Milk	4.23	1.54–2.98

[a] Estimates were developed by weighting data from impact studies to a U.S. average and calculating changes in yields and costs for the year of study.
[b] Estimates show the impact of a 20% cost increase on variable cost items for crops in 1975. The 20% cost increase was applied to a range in quantities of energy used in livestock production as a percentage of nonfeed variable cost.

handle. Without considering joint costs and other restrictions, diesel's cost effectiveness at today's prices in relation to gasoline per horsepower hour is about 2:1; that for British thermal unit is less impressive. The cost effectiveness of natural gas in relation to gasoline is about 4:1 per horsepower hour and 5:1 per British thermal units (USDA, ERS; Strathmann). The decision problem as to which source and how much to purchase is more difficult than that of a feed manufacturer determining the purchases of corn, sorghum, or soybean meal because of the fixed capital inflexibilities.

The consequences on variable production costs for crops due to an overall 20% cost increase for the highly energy related items are shown in the upper right of table 1.[1] These costs items include fertilizer, chemicals, fuel, and lubrication (Krenz and Garst) and assume a constant purchased input mix.[2] In the short run, farmers can't shift among energy sources. In the longer run, the feasibility of shifting to minimum tillage as an energy conservation measure is limited because reduced fuel costs frequently are offset by increased use of herbicides, which depend on fossil fuels, and amplified environmental problems (USDA). Consequently, it was assumed that over the next five years, farmers will have little opportunity to substitute other inputs for those dependent on fossil fuels. The data show corn and cotton variable costs would rise substantially as energy-related input prices increase by 20%. Wheat costs also would rise perceptibly but soybeans would be somewhat less affected.

The changes on nonfeed variable costs for livestock commodities are shown in the lower right of table 1. The low end of the ranges are Economic Research Service estimates which include gasoline, diesel, and liquefied petroleum gas used in livestock production. The high values at the upper end of the range also include natural gas and electricity. These are California state estimates (Cervinka et al.) except for turkeys which are from a large private firm in Minnesota. The upper ends of the range are 1.5–5 times those of the lower end.[3] However, the sensitivity on farm income or food costs may be minimal because only 21% of the fuel used in farm production in 1973 was used for livestock (USDA, ERS, p. 23).

POLYSIM Results

POLYSIM was used to estimate the intercommodity impacts of the environmental constraints and energy related cost increases at the rates shown in table 1. This simulation model estimates deviations from a base scenario of supply, utilization, prices, income, and costs of major crop and livestock commodities. In preparing POLYSIM, the base scenario variable costs per acre and nonfeed costs per pound were altered to represent the impacts of immediate environmental restraints, and two scenarios about periodic energy-related input cost increases of 10% and 20% per year. Since farmers' decisions on acreage and purchased inputs are affected by general cost changes, the results of energy price rises were added to the index for production items, interest, taxes, and wage rates

[1] In a recent delphi exercise done at USDA, the modal probability for tripling energy prices within a single year by 1985 was 40%; the range was 0%–50%.

[2] In cotton, 50% of the ginning cost was also assumed to be energy related.

[3] There are substantial opportunities for energy conservation through tightening management practices.

Table 2. Economic Stress on Selected Food and Fiber Variables, 1975–79 Average

Item	Acreage	Yield	Production	Domestic Use	Export	Price
			%			
Crop impacts:						
Feed grain	−1.2 to −2.4	−9.7 to −14.8	−10.8 to −16.8	−9.1 to −14.4	−13.2 to −21.0	27 to 42
Wheat	0.6 to −0.7	−12.2 to −16.6	−11.5 to −16.8	−6.8 to −10.9	−5.8 to −10.4	40 to 65
Soybeans	−4.6 to −7.8	−0.5 to −1.3	−5.1 to −9.0	−5.2 to −9.2	−4.8 to −8.6	10 to 18
Cotton	−1.5 to −1.8	−2.7 to −13.9	−4.3 to −15.8	−1.2 to −2.7	−1.3 to −2.8	8 to 17
Livestock impacts:						
Beef			−0.6 to −1.0			6 to 9
Hogs			−3.7 to −6.1			9 to 14
Sheep			−0.1 to −0.2			3 to 5
Broilers			−3.4 to −5.6			7 to 11
Turkeys			−3.0 to −4.9			6 to 10
Eggs			−1.3 to −2.1			7 to 12
Milk			−0.1 to −0.3			1 to 2

Note: The impacts of 10% energy cost increases on crops and low requirements for livestock are on the left of each column set. The impacts of 20% energy cost increases on crops and high requirements for livestock are on the right.

excluding feed and feeder livestock.[4] The output per unit of input variables for feed grains, wheat, beef, and hogs were also subjected to reduced technology. An operating rule, included for each crop, specified that variable production expenses must be less than a specified percentage of lagged cash receipts.[5] This operating rule was necessary because if farmers did not curtail purchased inputs, production expenses would surpass cash receipts. It was postulated that curtailment of purchased inputs would reduce yields as well as per acre costs.

The model showed that 20% per year energy cost increases could have a sharply depressing economic effect on yield of most crops as shown in table 2. Crop prices could push sharply higher but this would not be completely carried through to cash receipts as quantity demanded would be down.[6] Livestock production could be off and prices would rise substantially, especially for the grain-dependent varieties such as pork, broilers, turkeys, and eggs. Consumer expenditures would be up 2% but net farm income would fall off by one-third.

Energy cost increases of only one-half those above would have significantly less of a depressing economic stress on yield. Crop prices would be one-half to two-thirds as strong, and livestock production would be somewhat better. There would be a slightly smaller impact on consumer expenditures but net farm income could still be off by over 15%.

Conclusion

The impact of 10%–20% per year cost increases for energy-related inputs on prices and quantities of major crops greatly surpasses those associated with environmental restraints. In response to the economic stress of increasing energy-related costs, farmers may curtail fertilizer, irrigation, cultivation, pesticides, and herbicides due to the squeeze on farm income and lead to sharply declining yields.

The stress on net farm income indicates that something will have to bend. The pressures for adjustment may reduce the demand for purchased farm inputs and cause a softening in the price rise of energy-related items. The economic pressures may also provide incentives for farmers to improve management practices such that these inputs are used more efficiently. This study shows the importance of research on the decision framework for purchased farm inputs and its efficiency of use. Such information can be summarized in alternative crop and livestock budgets. These data for both quantities and prices are an important underpinning for an integrated analysis.

Interrelationships among commodities, represented in this study by elasticities, are also

[4] Since 37.5% of the index is energy related, it was increased by 3.75 for each 10% change in energy costs.

[5] Cost and cash receipt data for 1967–72 indicated the maximum of this percent for corn as 82%, wheat 46%, soybeans 33%, and cotton 107%. This study used the proportions: 0.8 corn, 0.5 wheat, 0.6 soybeans, and 1.0 cotton.

[6] No allowance was made for shifting demand because of changes in consumer income which could result in the economy from higher-cost energy.

important. Since elasticities represent decision makers' behavioral response, research is needed on how elasticities vary in relation to the economic stress. For environmental and energy policy decision making, the results need to include the effects on retail prices due to their impacts in the processing, transportation, and distribution components. With over half of the consumers' food dollar going to the farm-retail spread, these components cannot be ignored.

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Risk and Uncertainty in U.S. Agriculture
(W. D. Toussaint, North Carolina State University, Chairman)

World Agriculture, Commodity Policy, and Price Variability

D. Gale Johnson

The primary emphasis in this paper will be upon governmental agricultural commodity policies and their effects upon price variability. It is the commodity policies of the governments of the world that provide the links between what occurs in one part of the world and in the rest of the world's food and agricultural systems.

When one discusses price variability or price stability in today's world, one must be quite specific in indicating the context. The market for most farm products is so fragmented as a result of governmental regulations and interferences with trade across national boundaries that there is often little relationship between the behavior of a particular price series, such as prices received by farmers for grain, over time in different countries. Not only are there substantial differences in prices for approximately the same product at a moment of time, but there are major changes in the differences over time. The differential changes reflect primarily the effects of governmental policies, though to some small degree variations in the costs of transportation can affect the difference in prices between two points in space.

There is an obvious point, which I must admit eluded me in several abortive efforts to prepare this paper, that I feel is worth making. If governments are interested in price stability for agricultural commodities, their primary interest is in stability of prices within their own countries. This is not to say that governments have no interest in the stability of prices at which farm products are traded among nations, but past behavior of most governments and even a cursory examination of policies and programs designed to stabilize prices indicate that there is far less concern with the stability of prices outside than inside national boundaries. This is hardly a surprising conclusion.

In fact, the concern of most governments with internal price stability, with little or no regard for external effects, is comparable to the primary concern of governments with internal resource adjustments in agriculture. The agricultural and trade policies that were followed in recent years by most industrial nations to minimize their own need to adjust forced other nations to undergo relatively larger adjustments than would have been needed if all nations had participated on a more equal basis in the required resource adjustments.

There has been little recognition of the extent to which one nation or region achieves price stability at the expense of instability to others. This has not been an important issue in international negotiations or in trade negotiations. Where price stability has been considered an issue, it is in terms of arrangements that would limit fluctuations in international prices through commodity agreements or buffer stocks. The effects of national policies on price instability elsewhere have received almost no attention in such discussions.

The causes of international price instability have generally been attributed to supply fluctuations due largely to output variations resulting from natural phenomena, the breakdown of buffer stock arrangements, or fluctuations in demand over the course of business cycles. Instability has also been attributed to cobweb-like phenomena for tree crops or sugar where the time lag between investment and production can lead to alternating periods of high and low levels of production. These

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causes are real; there can be no doubt about them. But what can be doubted is whether these causes are the primary ones, at least for the very wide variations in international prices of most farm products such as we have seen in the past three years or perhaps even during the great depression.

National Price Stabilization

Market price stabilization requires that either the demand or supply functions be very elastic. Practically, for a given geographic area relatively little can be done to make demand functions highly elastic. Thus, programs designed to achieve market price stability must work through modifications of the supply function. The supply function for a given geographic area can be made very elastic in one of two main ways—by managing exports and/or imports and by storage.[1] Obviously the two techniques can be combined, as they have been in the United States and Canada for most of the past three decades.

The different methods of achieving an elastic supply curve for a given geographic area have very different effects upon prices in international markets. The control of imports and/or exports to stabilize internal prices increases the variability of prices elsewhere in the world. If internal prices are fully stabilized by controlling the flow of trade, this means that the price elasticity of demand for imports or the price elasticity of supply for exports, whichever is relevant, is zero. None of the variations in world supply and demand is absorbed by a country or region following such a system. All of the price effects of variations in supply or demand thus must be absorbed by others.

The effects of such policies of national price stabilization through the control of trade can perhaps be visualized best through a hypothetical example. Assume that half of the world's consumption of grain occurs within economies that stabilize internal prices through the control of trade. There is an autonomous shock that reduces the world's output of grain by 4%, and the only stocks that exist are working stocks. Assume further that the short-run price elasticity of demand for grain for the world is -0.1. The effects of the national price stabilization schemes are to require prices in the part of the world that normally consumes half of the world's grain to reduce their use by 8%. If the price elasticity of demand were -0.1 in this part of the world, the increase in price from a world production shortfall of 4%, assuming stable demand, would be 80% (approximately). If there were no national price stabilization schemes through the control of trade, the increase in price for the world would be 40% (approximately). Thus, half the world following such schemes doubles the price swings for the rest of the world unless there are stocks to absorb the shortfall in production.

Price Stabilization through Storage

If prices are stabilized through accumulation and de-accumulation of stocks, demand and production variability would be absorbed through changes in stocks. At some cost, prices could be stabilized within a specified price range—not with certainty unless the cost approached infinity but with a very high probability of success.

In fact, during the 1960s for wheat and the feed grains, the world came close to having a storage system that stabilized the international prices of these grains to a remarkable degree. It was a policy operated primarily by the United States and Canada with a late assist from Australia. The primary objective of the storage policies was not price stability; the storage function was largely an inadvertent outgrowth of efforts to increase prices and returns for the grains. In fact, the storage role was not only inadvertent but was also largely unwanted.

One of the major factors in the substantial modification of the U.S. farm programs during the early 1960s was the political concern over the high costs of storing the grain (and cotton) that could not be disposed of at the price sup-

[1] It could be argued that storage is a means of making the demand function highly elastic. When stocks are being increased, it is clearly appropriate to speak in terms of the demand function. However, since stocks can be decreased as well as increased and it is the supply available for consumption that adjusts rather than prices and consumption, I have considered a buffer stocks operation as a means of making the supply function for a given time period highly elastic. The underlying effects are the same, of course, whether one views a buffer stock operation as either a demand or supply phenomenon.

There are some other methods of making the supply somewhat more elastic than it would otherwise be, such as marketing limitations or acreage controls or destruction of part of the output. Price discrimination, as in fluid milk markets, can be used to make the supply to one segment of the market highly elastic by reducing the elasticity of supply to other segments of the market, but the methods discussed in the text are the major ones with relatively broad applicability.

port levels then prevailing. Similarly, the revisions in our farm programs that came in the late 1960s and early 1970s were motivated by the same considerations—the fear that stocks would increase to levels that could not be politically sustained. This was the view not only in the United States but also in Australia and Canada. The three governments took steps to drastically reduce the production of wheat and, in fact, accomplished this end. In the process, stocks of wheat held by the major grain exporters were substantially reduced from mid-1970 to mid-1972 by almost 20 milion tons or by one-third (Johnson, p. 55).[2] The reduction in the stocks of wheat and the unwillingness of the United States to accumulate large quantities of feed grains occurred even though the absolute level of grain stocks in the exporting countries was significantly lower than in the early 1960s. In mid-1960 and mid-1961, the grain stocks of the major exporters represented about 15% of world grain production. In mid-1970, such stocks equalled 10% of world production. Even so, the three major grain exporters desired to reduce stocks further and did so.

As noted earlier, the storage and pricing policies of the major exporters achieved substantial stability of the export prices of grain during the 1960s (Johnson, pp. 54–55). For the crop years 1960–71, wheat prices were held within a range of \$59 to \$65 per metric ton in eleven of the twelve years; in one year (1969–70) the annual average price was \$53. Corn prices were nearly as stable being held within a range of \$47 to \$57 per ton except for 1970, the year of the corn blight. Even in that year, the annual average export price was \$61.

The price stability during the 1960s was achieved during a period of significant variability in world grain production. In fact, the absolute shortfall of world grain production below trend during 1961–62 through 1965–66 was greater than during 1971–72 through 1974–75, 72 million tons compared to 36 million tons. Even if 1970–71 is added to the later period to include the effects of the corn blight on U.S. and world production, the shortfall for the period in the 1970s was 62 million tons. The shortfall of production below trend in the 1970s, relative to trend production and consumption, was at most two-thirds as large as during the first part of the 1960s (Johnson, p. 51).

[2] The tons used in this paper are metric tons.

Why, then, was the behavior of the prices in the international markets so different between the two periods? One reason was that the major exporters had held their stock levels to a lower level in the 1970s than in the 1960s. There is absolutely no evidence that, except for India, any country in the world made any effort to increase stocks as an offset to the declines in North America and Australia(UN, FAO 1974, p. 7). Thus, the change in storage policy of the major exporters appeared to be acceptable to the major importers. If there was any anxiety, it did not find expression in increased stocks.

Price Policies and International Instability

But I believe that a second reason was far more important as an explanation of the different price behavior in the 1970s as compared with the 1960s than the lower level of grain stocks in the later period. This reason was that a much larger percentage of the world's grain production and consumption in the 1970s than in the 1960s occurred within the framework of policies to achieve internal price stability through the control of imports and/or exports. It was not so much that basic policies had changed as it was that either the ability or the will to pursue price stabilization policies more effectively had changed.

For example, the basic features of the announced agricultural and food price policies of the Soviet Union were the same in 1972 as in 1963. Prices paid to producers were fixed, and prices at which farm products were sold as farm inputs or to consumers were also fixed and stable. The difference between 1963 and 1972 was that a much greater effort was made in the later year to make the prices effective prices, to more nearly equate supply to demand at those prices. In the earlier period, substantial shortfalls of supply relative to demand were tolerated; in the later period, serious efforts were made to eliminate or minimize the shortfalls. Thus, after the poor crop of 1963, the Soviet Union imported only about one-third of the grain production shortfall; the same relationship held following the poor 1965 crop. But in 1972–73, net grain imports exceeded the production shortfall relative to the previous year by approximately enough to maintain use at the trend level for 1972–73 (Johnson, p. 28).

Similar changes in the effectiveness of implementing price stabilization policies occurred in the European Community and, probably, in China. It is generally ignored that China has imported more grain, on the average, during the past three years than during the very difficult years in the early 1960s, or that since 1969–70 China has had larger aggregate net imports of grain than the Soviet Union (USDA, p. 24).[3] It appears that the countries of Eastern Europe and Western Europe also have effectively implemented policies to stabilize prices and use (around a rising trend) in recent years.

I earlier used a hypothetical example in which it was assumed that half of the world's grain use occurred within the framework of national price stabilization achieved primarily by control of trade. The level of one-half was not chosen arbitrarily. Approximately one-half of the world's grain use in recent years has occurred in the Soviet Union, the rest of Europe, and China (USDA, p. 24). These regions of the world increased their share of world grain use from 49% in 1969–70 through 1971–72 to 52% in 1974–75. In fact, the absolute increase in grain use of 68 million tons in these areas in 1974–75, compared to the earlier period, almost equalled the increase in world grain use of 73 million tons; the rest of the world increased grain use by only 5 million tons.

It would be an interesting exercise to determine how much the increase in the average price of grain received by farmers increased in the world between, say, 1971 and 1973 and 1974. A farmer in the United States would refer to an increase of approximately 175% in nominal prices, though perhaps 75% in real prices.[4] I have made a rough guess for the world as a whole, and it is little more than a guess. It is that the real price of grain received by the world's farmers increased by no more than 40% between 1971 and 1974. In the European Community it appears that the real grain price actually declined over this period (Johnson, p. 34).

If a nation or region is successful in achieving price stability, prices do not serve the function of influencing either consumption or production when the world's demand-supply balance has changed. Thus, as noted before, all of the adjustment to the variability of supply and demand must be made elsewhere in the world. In the recent period these adjustments fell primarily upon two groups of countries: the major grain exporters and the low income, developing countries that imported grain.

There were, of course, other factors that increased world prices of grain. One was the devaluation of the Canadian and American dollar. The dollar prices of grain could have been increased by such devaluations by perhaps 15%; with that increase the real price of grain to the major importers would have remained unchanged. There was obviously some speculative overreaction to the situation that developed in 1973 and 1974. However, it is not at all obvious that the major speculators consisted of evil individuals that frequent the grain pits of the Chicago Board of Trade. Governments or governmental purchasing agents may well have been far more important, though this is only an impression that I cannot document. Another factor was that the major exporters held to low export prices for grains for too long during the summer of 1972. Pricing policies that had worked reasonably well for more than a decade were simply inappropriate in the situation that arose.

The radical interference with the operation of the market due to the U.S. wheat export subsidy resulted in maintaining the export price of wheat at too low a level. Without the export subsidy, market prices would have much more promptly reflected the impact of the enormous grain exports contracted for in 1972. No one knows, outside of a few individuals in Moscow, how much impact substantially higher grain prices would have had on the amount of Soviet imports. Given the level of purchases already made in 1975 at significantly higher real prices than in 1972, it is not clear that higher prices in 1972 would have had a significant impact on their imports. This may sound as though their behavior was irrational. However, imported grain at $140 to $150 per ton is in the range of the Soviet average procurement price and significantly below marginal procurement prices.[5] It could be true that in the range of grain prices of $75 to $150

[3] However, Chinese imports have not exhibited the erratic behavior exemplified by the trade of the Soviet Union. Chinese grain imports do not appear to have been significantly influenced by the real price of grain.

[4] The estimated changes in prices do not include the direct payments received by U.S. farmers. If these were included in the returns for 1971, the increase in returns for the later years would be significantly less than 175%. The data refer to crop years.

[5] In this calculation, the official exchange rate of 1 ruble = $1.45 is used.

per ton, their import demand was very inelastic. I do not know that this is the case, but I would not be surprised if it were.

Reserves and International Price Stability

The conventional argument for a reserve is to offset uncontrolled variations in supply. This argument may be valid for an individual country that does not engage in international trade. It is not the valid explanation for the holding of substantial stocks in excess of working stocks for the world as a whole. Yagil Danin, Daniel Sumner, and I have estimated the optimal grain reserves for the world for 1948–1973 if there were free trade in grains (p. 27).

The criterion for optimal grain reserves was that the expected increase in price would equal the expected increase in marginal cost of storage. Storage costs were estimated to be \$7.50 per ton and a real rate of interest of 5% was assumed. Given the probability distribution of world grain production, based on actual variability of grain production for a period of approximately twenty-five years, we found that in only one year out of five carry-over stocks would be expected to be positive, and in only one year out of twenty would such stocks exceed 10 million tons. This was for a level of world grain production of approximately 1.2 billion tons. While if we had taken into account demand variability—the demand function was assumed constant except for a trend coefficient—carry-over levels would have been increased by a few million tons. However, we assumed a rather low price elasticity of demand (−0.1), and this probably resulted in an overestimate of carry-over levels.

Thus, for the world as a whole, grain production variability is not large enough to make it profitable to hold large reserves. What may make it profitable to hold substantial reserves are the governmental policies designed to achieve a high degree of price stability for individual countries or regional groupings such as the European Community. These policies result in significant year-to-year variability in the excess demand and supply functions for grain by these countries or regions. In the absence of reserves, such variations in the demand for imports or the supply of exports result in variations in the international prices of grain.

Would it be profitable for someone—governments or private traders—to hold carry-over stocks in response to largely policy-induced variations in import demand and the production variability in the major exporting countries? The answer to that question is clearly in the affirmative. Before the massive direct and modern governmental intervention in the markets for farm products, which can be dated from about 1930, the private market did hold substantial carry-over stocks of grain, especially wheat. Stated approximately for wheat, in the United States about half of annual production deviations, either positive or negative, were offset by variations in carry-over and most of the remainder by variations in exports from 1896 through 1927 (Working, p. 173).

During the first part of this century, substantial interferences with the trade in grain existed, but the interferences consisted of specific tariff duties. In many countries, especially in Western Europe, the tariffs were highly protective, but imports were determined primarily by market phenomenon, not by a bureaucrat or a legislature. Thus, it is possible that the current governmental policies have introduced such a greater degree of uncertainty into the international grain market that the private trade would be less effective in minimizing price fluctuations than it was a half century ago.

Quite frankly, we do not know whether it would be in the interest of the governments of the major exporters to jointly or singly adopt a carry-over policy for the grains not as a price support measure but as an investment. I hope that research that I am just now beginning, supported by the National Science Foundation, will provide at least a partial answer. An attempt will be made to determine the probability distributions of import demand functions for wheat and the feed grains. If this can be done, it should be possible to determine what the carry-over levels for the United States or for the major exporters should be for any given total supply at the beginning of a year. One assumption that will be made is that the expected marginal return from the investment in carry-over stocks should equal the expected marginal costs.

Some may argue that this approach will result in relatively small levels of carry-overs, certainly much smaller than held by the major exporters in the early 1960s and probably lower than was held in 1972. If true, and I do not know if this will be the case, who should

pay for the losses incurred in holding larger stocks than implied by the optimal inventory rule? Should it be producers in the exporting countries in return for greater price stability? Should it be the taxpayers in the major exporting countries? Or should it be the taxpayers in the importing countries and consumers generally who should pay?

A persuasive case has been made that it is consumers who gain from a reserve policy (UN, FAO 1975, p. 7). The case depends, to a considerable degree, on the assumption that the price elasticity of demand becomes smaller absolutely as price increases. If this assumption is correct, then shortfalls in supplies such as were witnessed in 1973 and 1974 result in very large transfers of income from consumers to producers. Consumers thus might find it in their interest to subsidize the holding of stocks in a greater amount than would be called for by the optimal storage or profitability rule.

If the case for consumer benefits is valid, then it is probably not in the interest of grain producers to subsidize or to encourage the holding of stocks larger than indicated by the optimal carry-over rule. However, it is possible that the exporters may find it necessary to hold fairly substantial reserves as a means of inducing importers to hold their degree of self-sufficiency in check or to actually decrease it (Johnson, p. 58).

Concluding Comments

The world need not have a period of price instability for major storable farm products such as it has witnessed since 1972 and is likely to have over the next year or more. If there were substantial liberalization of trade in farm products, price instability would be significantly reduced for internationally traded products. Trade liberalization would permit private traders and marketing firms, whether publicly or privately owned, to engage in price- and supply-stabilizing reserves. There would remain considerable price instability, but the wide swings of recent and near future years almost certainly would be avoided.

Realistically, there is little hope of enough trade liberalization over the next decade to make a significant contribution to international price stability. It is not only Western Europe and Japan that would have to modify domestic agricultural policies but also the Soviet Union and China.

Given the numerous and uncoordinated national efforts to achieve internal price stability, the only feasible approach for achieving price stability in the international markets is through the creation of commodity reserves. Probably the only significant possibility of establishing a reserve policy that could be sustained and would contribute a significant degree of stability to international markets without destroying the capacity of the price system to influence the allocation of resources and consumption decisions in a reasonably efficient manner would be through the cooperative efforts of the three major grain exporters. But if such a cooperative effort attempted to hold price changes within very narrow limits, such as 25%, the effort would fail due to the unacceptably large costs that would be involved.

Price stability has economic and social values. However, with national agricultural policies as they are in countries that consume one-half of the world's grain, the costs of achieving a substantial degree of price stability in international markets will be large. It is a truism that the price stability objective must be related to a level of costs that is acceptable to those who will bear those costs.

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Energy, Government Policies, and the Structure of the Food and Fiber System

George D. Irwin and J. B. Penn

It has become almost trite to suggest that the United States and the world are presently in a fundamentally changed economic situation requiring new diagnoses, prescriptions, and treatments. However, many have reached that conclusion after an assessment of recent economic events, including two devaluations of the U.S. dollar, formation of price-raising raw material-producing country cartels and threats of others, wage and price controls, and their lingering distortions, stagflation, U.S. balance of payments-inflow of petrodollars, expanded U.S. trade in agricultural commodities-detente with new trading partners, growing obsolescence of U.S. manufacturing plant and equipment relative to major trading nations of Europe and Japan, decline in the rate of U.S. technological innovation relative to the rest of the world, slowed growth rate of the U.S. labor force, environmental impact regulations, and more energy conscious consumers and producers.

Taken individually, the economic system would likely respond to these shocks in traditional ways. Interacting together, however, they strain our ability to sort out past impacts and to predict future changes. Many of these events are new and hence, data are not organized for analyzing them, which contributes to greater uncertainty. The economic units of the system are having difficulty in formulating expectations upon which to base decisions.

Our purposes in this paper are to evaluate the energy-environment component of this confluence of forces, giving special attention to government policies as both a source of and solution to problems of uncertainty and to discuss important potential impacts of uncertainty forces in general on the organizational structure of the food and fiber system. The initial focus is on economic units directly affected by recent economic events, but the ultimate concern is with the likely effects on the growth rate of our domestic economy, on the economic organization of production, on our ability to compete in world trade, and on our role in reducing world hunger.

Economic growth in excess of the rate of population growth has been the formula by which the United States has developed the highest standard of living in the world. Labor-saving technology has permitted the economic pie to yield an ever larger slice to each person. Growth has been viewed as subject only to the constraints of the rate of technological advance, the rate of saving and capital formation available to finance new technology, and the rate of growth of the labor force. Two new kinds of apparent constraints have now entered the growth equation: environmental and natural resource considerations, interacting peculiarly in the context of energy. Unfortunately, their emergence has coincided with an apparent downtrend in the relative rate of U.S. technological advance (Boretsky), with a rising concern about the world population-food supply balance, and with the predominant U.S. contribution to maintaining the balance.

The new constraints are of special concern in the food and fiber system. We depend on energy in our processes and are stewards of large amounts of land and water resources which are subject to environmental hazards. The growth potential of our markets is directly related to both U.S. and world economic growth. Food exports have both balance of payments and human survival dimensions. Thus, the concern about quality of life manifest in many environmental regulations has become transformed into concern about the more basic elements of world food supply and productive capacity. Finally, the magnitude of recent economic change creates concern that the organization of our economic system may prove unable to cope with the combined impacts and may undergo a major structural adjustment in response.

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The Energy Situation

The current energy situation developed over a long period and is a result of many converging forces. Domestically, energy consumption has more than doubled since 1940, while production has increased one and one-half times. In 1940, production exceeded consumption by 8%, but at the time of the 1973 Arab oil embargo, we were importing 17% of all energy and fully one-third of our petroleum (*International Economic Report*).

The U.S. economy made several significant initial responses in 1974 to the higher oil prices. Oil consumption decreased at a 3.9% annual rate, while during the past two decades, it had been increasing at an increasing rate, reaching 7.2% annually in 1971–73. Oil imports made an astounding turnaround, going from a 22% annual rate of increase in 1970–73 to a 1.7% decrease in 1974. However, the percentage of oil from foreign producers actually increased in 1974 as domestic production continued to decline. All prices (GNP deflator basis) rose 10% in 1974, energy prices rose 29%, and aggregate consumer spending on automobiles and parts and energy dropped 7%. Thus, some flexibility was demonstrated.

Cost impacts of higher energy prices are still not fully understood, due partly to confounding with a great variety of economic shocks which occurred concurrently and due partly to the extent to which energy costs are spread throughout the U.S. economy. We still face the uncertainty over how much substitution and induced new technology will affect supply and how much consumption patterns of all goods will adjust.

The way OPEC countries spent their additional oil revenues was of great interest, but first-year developments turned out to be considerably less severe than had been feared. OPEC countries received some $100 billion of export income, 95% from oil, and over 60% was available for investment. Initially, most was put in short-term deposits, and the United States received only about one-fifth of those, far less than expected.

Concern was expressed that the deposits were temporary, awaiting substantial investments in real assets. Specific fears were of possible takeover of strategic industries in developed countries, including U.S. rural real estate and food production. Congressional hearings demonstrated that little factual information was available on inbound investment and resulted in the Foreign Investment Study Act of 1974. It mandates a benchmark survey to determine the current amount of foreign investment by major types. Various other legislative proposals have been introduced to provide monitoring of rate of change in such investment, and attempts have been made to collate the information currently collected by Federal agencies but for other purposes. Morrison and Krause recently completed a review of federal and state statutory limits on such investment and found them to be nonexistent, minor, possibly unconstitutional, or avoidable in most cases.

The year 1974 also saw major efforts to fill other data gaps on energy. A report prepared by the Economic Research Service (USDA) concluded that the food side of the food and fiber system uses about 13% of total U.S. energy requirements and that utilization was increasing at about 4% per year, the same as the rest of the economy. Within the system, farm production accounts for about 22%, farm family living 12%, food processing 28%, marketing and distribution 18%, and selected input industries 20%. Total 1980 requirements are estimated to be up 11.3%, with a decrease in family living due to declining numbers of farm households, a 4% increase in farm production requirements, and a 20%–30% increase in inputs, processing, and distribution industries.

Cartel pricing of export oil also has important impacts on the terms of trade between nations. The ramifications are complex, depending on whether additional U.S. expenditures for oil are used by OPEC countries for consumption or investment, the sources of the consumption or investment goods, the location and type of financial investments, and the related policies of the United States. Since agricultural products are a major export item, terms-of-trade considerations obviously give us a great stake in the outcome of international oil money movements.

Contributions of Energy-Environment to Uncertainty

Two levels of uncertainty arise from the energy situation. First, what are the final impacts of the major 1974 shift in the price level for petroleum? Even if the oil price increase were a one-time shock, U.S. and world economies may go through many rounds of adjustment in response. There is a great deal

of uncertainty about the eventual impacts on these economic systems. Second, what are the prospects of future irregular variability in energy prices and supplies? For the domestic economy, these questions interrelate closely with efforts to reduce dependence on foreign energy supplies, further implementation of environmental regulations, and with formulation of new government energy-environment policies which sometimes must treat inherently conflicting objectives.

In future considerations of this problem, a crucial relationship is close past correlations among technological advancement, gross national product growth, and Btu. consumption. Boretsky asserts that per capita Btu. consumption in civilian production "is probably the single most comprehensive indicator of overall relative technical advancement" (p. 71). Does the recent shortage of Btu. energy signal a change from a growth tradition to one of no growth? While there is no definite answer yet, recent studies have explored this central question from varying length of run perspectives.

Short-Term Impacts

Our own recent work involved use of a static, short-run, constrained input-output model to examine sectoral impacts of fuel shortages due to reduced oil imports or natural gas restrictions, both with and without allocation programs (Penn and Irwin; Penn, Irwin, and McCarl; McCarl et al.). This methodology provides insights by examining direct and secondary impacts of short-term quantity restrictions.

The results strongly illustrate interdependence of the food and fiber system with the rest of the economy. Indirect energy requirements of most sectors dominate their direct requirements. Allocations based on direct requirements at any predetermined output level were not effective in altering output combinations. They might, of course, be useful in overcoming real world bottlenecks and lags which are not treated explicitly by the model. The short-term availability of natural gas is a special and serious problem, since it accounts for some 30% of total food system Btu. use, especially for nitrogen fertilizer production and crop drying.

Generally, the agricultural sectors, in adjusting to fuel restrictions, demonstrated their "basic commodity" nature, following the path of the economy closely. Aggregate output is always reduced significantly less than the percentage cutback in the single energy source, even though the input-output model does not permit substitution in utilization among energy sources.

Long-Term Impacts

Substantial reductions in energy use appear to be possible without major economic costs in aggregates such as growth, employment, and GNP. The economy has considerable flexibility in adapting to changing resource availabilities and their relative prices. In addition, only a slight percentage change in consumer purchase habits can offset the growth drag of higher investment costs of pollution control or more expensive energy sources. However, some significant distributional impacts would occur between sectors.

Hudson and Jorgenson, using a very flexible model combining input-output and econometric techniques, estimated that an 8% saving in aggregate energy use was possible at a cost of only a 1% increase in average prices and a 0.4% decrease in real income. The composition of production was expected to change, with relatively slower growth in raw material industries, including agriculture, due to changed terms of trade and higher fuel prices.

Carter has provided additional evidence using a dynamic input-output model. She examines the question of whether the higher investment, domestic energy-producing technologies of nuclear electric generation and coal gasification retard growth of the economy. As is typical of first generation technologies, growth rates tended to be decreased, but only slightly. Carter demonstrated that only a minor decrease in propensity to consume could generate necessary capital formation to more than offset the increased technological cost. Thus, adjustments in consumer behavior patterns are extremely important to the whole economy. We hypothesize that the rising relative price of energy could cause other consumer adjustments which offset much of growth drag.

Energy-Environment Relationships

During the decade of the 1960s, the non-GNP portion of the implicit U.S. social welfare function was accorded higher priority. Environmental concerns came to the fore and were

recognized as externalities to individual firm decisions. Various taxation or regulatory devices were created to eliminate the discrepancy between private and social costs. In the process, our growth equation gained an environmental constraint.

A subsequent major concern is that these environmental policies may not be cost-free with respect to energy. Some initial reactions were for any environment-energy trade-off to be decided in favor of energy. With the 1973 expenditure for complying with environmental regulations some \$6.3 billion and a 1982 projection of \$28 billion (Hamrin), the question is important. Results do differ significantly when energy considerations are added to environmental analyses.

Impacts of current environmental regulations, taken alone, will not retard the aggregate growth rate, nor will jobs or prices be affected significantly, according to a recent review of studies (Hamrin). Expanded activity in air pollution control industries is a major offset. Carter's dynamic input-output formulation suggests a similar conclusion. However, distributional impacts on industries are significant in two ways. One, some eight industries made 80% of private pollution control investments in 1974, and their share will probably grow. A significant member is the food and kindred products processing industry. Second, all eight industries are in the basic group, so there is a potential ripple effect throughout the economy. Estimates indicate that 85% to 100% of these cost outlays will be passed through to consumers, depending on industry structure, availability of substitutes, elasticity of demand, size of the expenditure, etc., and that some of the remainder will be offset by raw material saving or other gains from salvaging wastes.

Various studies of a sector nature have examined questions of individual environmental restrictions on farming. Forster has shown that water pollution control rules would not have a severe impact on fed beef production but that the impact is regressive due to economies of size in compliance. Similarly, Gilliam and Martin showed that banning antibiotics in animal feeds tended to increase production costs, ultimately borne by producers or consumers, depending on one's assumptions about the industry's ability to pass through price increases.

Impacts, when energy constraints join environmental constraints, are indeed more significant. As demonstrated rather strikingly in Carter's work, neither higher cost in electric power-generating technology alone nor pollution control alone had much negative impact. But when the two constraints interacted, growth potential was cut almost one percentage point (from 3.5 to 2.6). When the impact of the dramatic, supply-induced price rise for all energy sources is added, the potential drag on economic growth indeed seems serious. However, the same sort of fear was felt for environmental regulations alone as they were being instituted in the 1960s, and these proved exaggerated. Carter, speaking only of the costs imposed by new energy technology and environmental regulation, concluded that "we can meet environmental standards and resource constraints over the next decade and still maintain or even increase present growth rates for conventional goods" (p. 591).

Energy Policy

Further adjustments are imposed by ever higher price levels achieved through cartel pricing or through U.S. counter policies to achieve greater energy independence. Their likely extent and nature is an increasingly important source of uncertainty, as more of the energy constraint is controlled by political processes in the United States and the rest of the world.

We do not know whether the OPEC cartel will be successful in maintaining or increasing petroleum prices. Even if it is not, we do not know whether they will periodically attain such success, thereby introducing additional variability.

The slow process of developing a U.S. energy policy is a major source of uncertainty. The long-run need appears to be for energy programs stressing development and conservation, but these may be inflationary in the short run (at a time when inflation is already a major economic concern), thus complicating development of short-run economic policy (*Economic Report of the President*, pp. 20–21). In addition, consensus has not developed on the nature of a long-run energy policy. The Administration proposed a series of programs designed to reduce dependence on imports by conserving energy, developing domestic sources, and developing a strategic reserve to blunt any repeated embargo by OPEC. The programs would rely on market forces across the board. The argument made for market

rather than rationing or allocation mechanisms was that the latter might have more undesirable structural consequences by making the economy less responsive and by tending to favor large and established firms.

An alternative viewpoint on U.S. energy policy would focus the impact of shortages directly to target on specific subsectors via selective rather than general energy price rises. Specific gasoline taxes have been voted upon, vetoed, and the veto sustained. Policy making is tortuous because of the complex regional interests among producers and consumers of each of the fuel types, environmentalists, and the wide variety of other special interests.

Intensive development of domestic energy sources could have a number of impacts. Coal and oil development could interfere with farm production in certain areas, either as competitors for land or for irrigation water. The level of prices established also may affect the spatial location of food production. Finally, adjustment in consumer purchases to the "tax" of higher oil prices, as well as direct taxes to control consumption, could alter overall consumption patterns. Farm commodities, to the extent they are demand inelastic, are less likely to be cut back than are levels of food processing.

Nordhaus identifies important questions yet to be resolved from the viewpoint of the domestic economy. Should the rate or direction of the economy be changed as a result of global shortages of natural resources? Are markets a reliable allocative mechanism for energy, or is some sort of intervention necessary? What are the best ways for insuring security of supply?

Structure of the Food and Fiber System

Our discussion indicates that the energy-environment complex has indeed raised some uncertainties which have tended to compound larger uncertainties from other sources. The first major adjustment set apparently will be in response to changing relative prices rendering differential impacts on sectors, not to changing aggregate growth in the economy, just as Carter and Youde hypothesized (p. 886). The next set of adjustments which must be examined involves consequences on organizational structure. The remaining discussion first considers various uncertainty sources and then focuses more specifically on applications to energy issues.

Comments on Theory

Frank Knight's *Risk, Uncertainty, and Profit* emphasized that entire economic systems evolve in response to the dominating impact of risk and uncertainty, but most attention has been focused on the dual question of how individual decision makers can or should respond to risk situations: consolidate, specialize, control the future, increase predictive power, diffuse, or avoid. Even in 1970, Coase was able to note: "What is curious about the treatment of problems of industrial organization in economics is that it does not now exist" (p. 60). While modern economic theory continues to develop in this area, it still does not provide a clear guide for empirical analysis,

Two alternatives have some rudimentary development, one in economic-industrial organization and one in the legal-economic boundary. Coase suggests that "the way an industry is organized is dependent on the relation between the costs of carrying out transactions on the market and the costs of organizing the same operation within the firm which can perform the task at lowest cost" (p. 64). Schultz has expanded the argument to say that new institutions are created, or activities are shifted among old ones for four types of reasons: to reduce transactions costs, to allocate risk, to link personal and functional income streams, or to handle public goods and services. Thus, both the relative costs of carrying risk internally and the willingness to bear it are crucial to future adjustments in economic organization.

The conventional economic viewpoint is developed along these same lines by theorists on the subject of market failure and by Arrow (1974), who argues that modification of the neoclassical analysis to include information provides the most reasonable approach to uncertainty. Arrow (1975) has also concluded from a theoretical argument that vertical integration may be encouraged solely due to uncertainty in the supply of upstream goods. The need for downstream firms will cause a situation thought of as competitive to tend toward imperfect competition. This improves the spot price forecast of inputs and enables the firm to choose its level of capital more confidently. It is well known that such struc-

tural characteristics alter the possibilities for behavior, introducing both possibilities and incentives for collusion. Energy price uncertainties might thus be expected to provide further incentive for these large firms to develop integrative devices for their input streams. On the other hand, energy cost increases for processing would tend to restrain a certain amount of product experimentation, which is characteristic behavior of large processors who might be the more active integrators (Padberg). However, we have seen no definitive work on the impact of uncertainty on firm size which takes as a variable the scope of activities undertaken by the firm. A further uncertainty restraining integration could be a change in U.S. eating habits (Winski), such as a back-to-the-basics movement brought on by consumer budget crunches during the recent recessionary-inflationary period. If we are experiencing a threshold change in eating habits rather than just a cyclical response, the ability of food manufacturers to follow behavioral patterns of the past may be lessened. On the other hand, users and exporters of farm products in raw or near-raw form may see incentives to tie ahead.

The second alternative, the legal-economic approach, has its roots in the concept of property rights (Cheung). Adjustments involving such rights are treated as the basic entities for economic analysis. When property rights are not clearly defined or when they are created, destroyed, or altered by some exogenous event or governmental restriction, resource allocation and economic organization may undergo adjustments. Looking at adjustment in terms of property rights seems to improve explanation and predictive power. The theory is not well developed and is yet to be integrated into our theoretic base.

Comments on Government Programs

Government programs may affect organizational structure directly by encouraging or discouraging growth of individual firms at a rate faster than growth in the aggregate market for their products, by either creating or providing assistance in overcoming barriers to entry, by encouraging or discouraging exit, or by altering the climate for merger and integration. They may affect organizational structure indirectly by institutional provisions, rationing, price controls, import quotas, allotments, or similar regulatory programs if these programs deliberately (or through oversight) alter the ownership of property rights within traditional exchange systems (Cheung). Resource allocation is affected and organizational structure adjusts by the same sort of processes followed whenever a deliberate, direct policy is implemented.

Dahl has contended that most public policies either have no structural impact on the food and fiber system or else are concentration-increasing. How about proposed energy policies? Their impacts on the food and fiber system are likely to be through price level as well as availability. We must expect problems of bottlenecks, both with allocation schemes for short-term quantity emergencies and long-term situations of technological introduction and phase-over. These may disadvantage certain industries, locations, or types of firms. Food costs include high energy prices, but food is also a basic commodity with inelastic demand. Impacts of rising energy prices are not likely to stifle volume of output. Instead, they are more likely to affect type, amount, form, and location of production and processing. They will raise the variable cost component of production, both directly and indirectly through other purchased inputs. This, in turn, further reduces the relative cushion of fixed costs, long the mainstay of farmers and small businessmen in weathering adverse years.

Summary

We have dealt with three general issues related to uncertainty in this paper: uncertainty about the overall nature of the energy situation, the question of whether the energy-environmental complex portends greater future uncertainty for the food and fiber sector, and the likely impacts on organizational structure.

Our conclusions are as follows: Uncertainty is likely to be greater in the future. Primary contributors are resource scarcities, domestic and world food demand, exchange rates and investment, inflation, greater political as well as economic interdependence, and environmental impacts. Thus, energy and environmental problems have merely added to these concerns. The food and fiber system is completely interdependent in the larger picture. Policies and anticipation of policies yet to be developed have a great impact on the level of uncertainty,

as well as on who will bear it. Current models for understanding change in organizational structure are not adequate but are slowly stimulating conceptual developments which will help focus analyses.

The energy-environment situation appears to have minor overall impact on GNP, employment, overall economic growth, and the like. But effects for certain sectors, including the food and fiber system, are quite significant, and impacts on individual firms may be even greater. The organizational structure impacts are likely to involve further evolution of existing institutions and techniques designed to deal with uncertainty. Organizational forms can be expected to continue to adjust control toward those units most willing to assume risk and those most innovative in coping with it. Devices to reduce uncertainty will proliferate, including massive efforts already underway in the area of information gathering. Economists once again have a bonanza of work, as they always do in an environment of scarcity and uncertainty.

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Risk Response Models and Their Use in Agricultural Policy Evaluation

Richard E. Just

The previous two papers have discussed the possible effects that proposed public policy may have on risk and uncertainty in the agricultural economic environment. Accordingly, I will argue that, before we can adequately evaluate policies which create new degrees of risk for agricultural producers, we must have better quantitative knowledge of how farmers will respond to changing risk in adjusting input and production decisions. I will then consider models for estimation of the effects of changing risk in agricultural supply response.

Response by decision makers to changes in risk has long been recognized as an important economic phenomenon. The study of decision makers' behavior toward risk began to be popularized as early as 1948 with the work of Friedman and Savage and later by the work of Markowitz and Tobin. Many agricultural experiment stations began during the mid-1950s to evaluate the risk associated with various agricultural enterprises (Heady, Kehrberg, and Jebe; Carter and Dean). These studies have freely acknowledged the importance of both price and production-related risk in determining agricultural input decisions and, hence, output. With increased interest in risk, research has centered on stochastic programming models and nonlinear objective criteria (indicative of utility maximization) which could be used to determine optimal reactions to changing risk. But while much work has been undertaken to determine the risk involved in farm decisions and how farmers should react to changing risk, it is my contention that the implications of risk for positive response studies have been seriously neglected.

In fact, the effects of risk on optimal input decisions have been examined through normative programming approaches (e.g. Freund) since the 1950s, but the effects of changing risk have thus far been considered only to a limited extent in positive models (Behrman; Just 1974a). In the programming approach, effects of changes in risk have been examined largely on a microlevel. This paper is particularly concerned with estimating risk response at the aggregate level so that policies which affect risk can be adequately evaluated. I first attempt to demonstrate by way of example the implications of policy evaluation with economic models which do not reflect producers' reaction to changes in risk. I then briefly review the state of the arts for two existing approaches in risk response estimation, i.e., the normative or programming approach and the positive or econometric approach. These reviews are restricted to a respresentative (rather than exhaustive) sample of those works which, to me, seem important in terms of agricultural policy evaluation.

The Importance of Risk Considerations in Policy Evaluation

Most aggregate response and empirical policy analyses with which I am familiar have emphasized behavior only toward price and yield levels and have failed to recognize the possible response to changing price and yield risk. If risk response is important in agricultural decisions, however, then the use of such models to evaluate policies which significantly impact on agricultural risk are of questionable validity. As a case in point, consider the farm commodity programs during the 1950s and 1960s which listed as their goals not only restriction of production and maintenance of income but also stabilization of prices and income. Much research has focused on determining the direct impact of the associated restrictive measures, and policies have been evaluated accordingly. But evaluation of the indirect effects resulting from the associated stabilization has received little attention.

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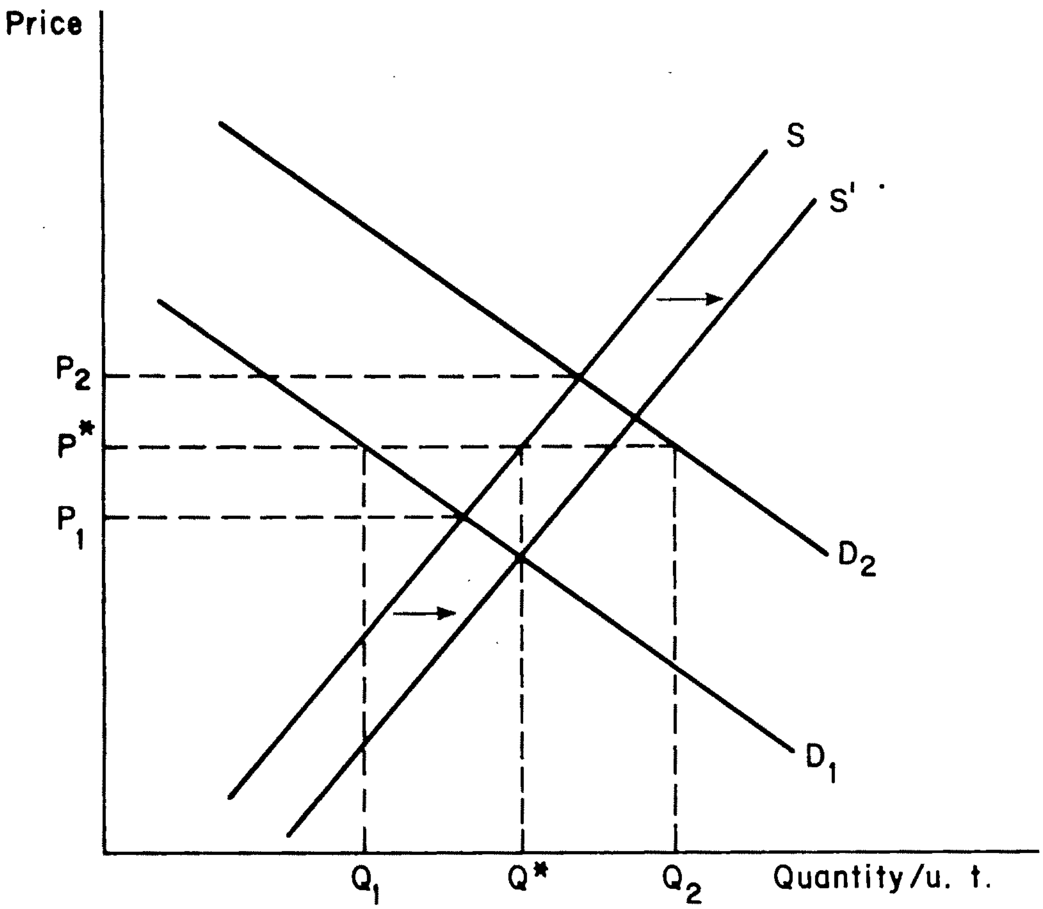

Figure 1. Implications of risk response

Some recent research in California has suggested that response to stabilization is indeed of significant empirical importance (Just 1974a). Using a positive model which can reflect risk response, the indirect response to stabilization appeared to almost offset the reduction in acreage directly attributable to restrictive measures in the cases of some voluntary programs. This result, of course, could not possibly be obtained with an empirical supply-response model which does not explicitly recognize growers' reactions to changing risk.

Consider a similar conceptual problem of stabilizing U.S. export demand by means of a world food buffer stock. In figure 1 export demands D_1 and D_2 each have probability 0.5, and export supply under uncertainty is represented by S. Now suppose a world buffer stock authority establishes a price $p^* = (p_1 + p_2)/2$ at which it will either purchase excess supply or fill excess demand. Without response to risk, this action would make the expected change in buffer stocks zero (if $Q_2 - Q^* = Q^* - Q_1$). If farmers are risk responsive, however, the more likely result is that the associated price stability will induce a shift in supply to S' as producers become more certain about price and possibly adopt more specialized technology (assuming risk averseness). Hence, excess supplies will generally be larger than excess demands at the announced price and, as a result, buffer stocks will begin to accumulate indefinitely (in expected value). A similar result would be obtained if p^* is merely established as a price support, and the excess supply in years of low demand, $Q^* - Q_1$, is transferred by buffer stocks to years of high demand. The role of risk in supply response thus offers a possible explanation for the accumulation of stocks during the 1950s at price-support and parity levels which seemed in line with historical prices.

Similar arguments could also be made on the input side indicating that destabilizing input supply leads to reduced input demand and, hence, reduced agricultural output. Thus, policies which affect agricultural fuel, fertilizer, and pesticide supplies should also be evaluated not only in terms of their directional impacts but also in terms of their stabilizing or destabilizing effects.

Such explicit risk considerations have usually been omitted in empirical policy analysis. The reason, I believe, is twofold. First, the underlying theory in most policy analyses is usually considered in a deterministic framework (e.g., Wallace, Griliches, Schmitz and Seckler). Furthermore, even in those studies which work in a stochastic framework, the possibility of response to risk is usually not considered (e.g., Massell 1969 and 1970; Hueth and Schmitz). Most of these studies have avoided the risk problem by assuming profit maximization. But, for example, in Massell's (1970) paper relating to agricultural price stabilization, he explicitly considers producers' risk preferences and still fails to consider the possible reactions to change in risk. Using figure 1, the gains in producer surplus or profits between S and S' below p^*, as well as the associated consumer gains, are thus omitted. Such an omission obviously causes the gains from stability to be seriously underestimated.

A second reason why empirical policy analysis has tended to ignore risk response is that appropriate models have not been developed for estimating risk response. At the session on evaluation of econometric models at the 1974 winter meetings, the general conclusion was that "better models are needed in the agricultural sector" (Popkin, p. 158). And King argued explicitly that "the most important thrust" in terms of supply response models is in developing "behavioral models relating to producer formulation of expectations of price and yield and risk" (p. 165). In this context, considerable progress has been made toward flexibility in estimating expectations or first moments of decision makers' subjective distributions (for prices, yields, etc.), but similar efforts are also needed to include flexibility in estimating models with subjective second moments if response to changing risk is to be adequately captured. Hence, in the remainder of this paper, I will be concerned with this latter, less developed problem of risk-response estimation.

Normative Risk Response Estimation

Two important possibilities exist for the quantitative determination of farmers' response to stabilization or destabilization of input prices, output prices, and yields. These are the two basic approaches for estimating supply curves (Nerlove and Bachman). In the normative approach, mathematical (programming or control theoretic) models which include price and yield risk can be developed for various farm classifications (I include King's production function approach in this category as did Nerlove and Bachman). By aggregating results over classifications, the net response to specific changes in risk structures can be examined. In the normative approach, problem-solving techniques are reaching a rather advanced stage. Stochastic programming algorithms have long been available and have been often used in agricultural settings (e.g., Rae; Hazell and Scandizzo). Statistical decision theory has also been an important tool for solving agricultural problems of choice among various risky alternatives (e.g., Eidman, Carter, and Dean). Both the stochastic programming and decision theoretic aspects, as well as considerable dynamic generalizations, have been combined in the adaptive stochastic control theory which has been developing in the engineering literature (e.g., Aoki, Murphy). Applications of the more general techniques in adaptive stochastic control to farm decision-making problems have been slow, however, because farmers' possibly multifactored objective criteria are difficult to determine empirically. Furthermore, most of these stochastic and dynamic considerations have been made in programming models only on a microlevel.

The normative approach, however, has not been widely used in aggregate supply analysis other than under the assumption of profit maximization. I am aware of only a couple of studies, such as the one discussed briefly by Hazell and Scandizzo, which attempt to include risk response in an aggregate normative model. And, to my knowledge, all normative work to this point has restricted decision makers' objective criteria to maximization of a mean-variance utility function of profit. This is a restrictive assumption by itself, but considerable problems have also been encountered with estimation of the mean-variance utility criteria as well as with estimation of decision makers' subjective expectations for prices and

yields (Hazell and Scandizzo, p. 243). The development of methodology for determining decision makers' objective criteria will probably continue to be slow and thus hinder (although not prevent) reliable aggregate normative estimation of risk response in the near future. However, the methodology for determining individual preferences has been progressing. Halter and Dean, as well as Webster and Kennedy, have developed methods for estimation of individual utility functions of agricultural producers. If better methods of estimating preferences on an aggregate level are developed, then more reliable normative estimates of risk response should be possible. With respect to estimation of producers' expectations for risk, however, the information derived from positive risk-response studies may be needed to improve normative risk models.

Positive Risk-Response Estimation

The positive approach to risk-response estimation, it seems to me, is more direct and holds promise at least for current research because information about objective criteria need not be specific and because the formulation of producers' subjective evaluation of risk need not be specified (completely) in advance. Simple econometric models of risk response have begun to be used for studying acreage response to both output price risk and yield risk and some models are of sufficient generality to reflect risk aversion as well as diversifying decision-making behavior in a multivariate response framework. The associated empirical work has indicated not only a considerable reaction to changes in risk but also, where the framework is sufficiently general, a significant interaction in risk-related response among agricultural enterprises.

The major approach developed thus far in estimating aggregate risk response involves, as King points out, modifying the general class of adaptive expectations models so that subjective expectations for the mean squared error of adaptive predictions is also included. Where y_t is the decision (response) variable and x_t and z_t are the explanatory (price or yield) variables, a general adaptive expectations model is given by

$$y_t = f(x^*_t, z^*_t),$$

$$x^*_t = \sum_{k=1}^{\infty} \alpha_k x_{t-k},$$

and

$$z^*_t = \sum_{k=1}^{\infty} \beta_k z_{t-k},$$

where x^*_t and z^*_t represent subjective expectations for x_t and z_t, respectively, for time t. With this model, the squares and cross products of the errors of predictions are given by $(x_t - x^*_t)^2$, $(z_t - z^*_t)^2$ and $(x_t - x^*_t)(z_t - z^*_t)$. Regarding these quantities as observations on risk (or on variances and covariances), expectations can be formed for the squared error and cross product of error by weighting past observations on risk, similar to the way subjective mean expectations are formed. The modified adaptive expectations model or the resulting adaptive risk model is thus

$$(1) \qquad y_t = f^*(x^*_t, z^*_t, u_t, v_t, w_t),$$

where

$$u_t = \sum_{k=1}^{\infty} \gamma_k (x_{t-k} - x^*_{t-k})^2,$$

$$v_t = \sum_{k=1}^{\infty} \delta_k (z_{t-k} - z^*_{t-k})^2,$$

and

$$w_t = \sum_{k=1}^{\infty} \rho_k (x_{t-k} - x^*_{t-k})(z_{t-k} - z^*_{t-k}).$$

Since this model reflects not only subjective variances but also subjective covariances, it can possibly reflect diversifying as well as risk-aversive response to a changing risk structure. Although only two explanatory variables are used here for expository purposes, the framework extends in an obvious manner when many explanatory and decision variables are important.

Behrman first began to consider risk response in this manner in a study of crop-supply response in Thailand. Behrman's model is essentially the same as in equation (1) above except that the subjective covariance term w_t is excluded, and all other subjective weighting parameters in the risk structure are arbitrarily prespecified. His equation is of the form

$$y_t = a_0 + a_1 x^*_t + a_2 z^*_t + a_3 u_t^{1/2} + a_4 v_t^{1/2},$$

where all weighting parameters ($\alpha_k, \beta_k, \gamma_k, \delta_k, \rho_k$) are 1/3 for $k = 1, 2, 3$ and 0 for all $k > 3$. Behrman defined x_t and z_t as output price and yield, respectively, and y_t as the land area

planted to the corresponding crop. In this framework, Behrman found that price and yield risk response was significant in many cases even in underdeveloped agriculture.

In a study of California agricultural crop acreage response, the model in equation (1) was applied more generally (Just 1974a). Interaction in risk response was investigated by considering risk terms for competing crops as well as for the crop in question, and subjective covariance terms, such as w_t (relating different crops), were also investigated. All subjective weighting parameters were estimated rather than prespecified, but the weights were constrained to have geometric distributions related by α_k, $\beta_k = (1 - \theta)\theta^k$, and γ_k, δ_k, $\rho_k = (1 - \phi)\phi^k$, where θ and ϕ are fixed parameters. Results of this study indicated that risk response was important in every case where acreage response was not dominated by strict acreage controls. Although the subjective covariance terms (w_t) were of little importance in explaining acreage response, the interaction in risk response was significant in most cases.

The California study has also led to an important explanation relating to goodness-of-fit in risk-responsive versus traditional Nerlovian agricultural models and possibly explains a well-known criticism of Nerlovian models. This explanation, discussed previously by Just (1974a) and by King, indicates that the Nerlovian response model has possibly performed well for estimation purposes because in reduced form it can implicitly explain risk response. Both empirical and theoretical findings indicate (particularly when ϕ is large) that most of the effects of changing risk can enter through the lagged dependent variable which is used in estimating the reduced form of the Nerlovian model. Hence, the reduced form of the Nerlovian model (without risk terms) can possibly fit the data almost as well as the structural risk model in equation (1) when, in fact, risk response is significant. In this case, the predictive power of the Nerlovian model will generally be poorer than the risk model and, in particular, predictions will be poorer than estimation statistics indicate.

Although research supporting the latter possibility is not generally published (for obvious reasons), many complaints have been lodged that econometric predictions are poorer than statistics indicate they should be. For example, in their evaluation of econometric models in agriculture, Cromarty and Myers observe that "the contribution of the lagged dependent price variable will generally overpower any additional explanatory factors. This leads to internal estimating statistics that always appear impressive (high R^2 and low standard error) and a final estimate which tends to overshoot or undershoot the major turning points" (p. 174). When turning points are at least partially a result of changes in risk, this phenomenon is exactly what the results to which I refer would lead one to expect. An adequate consideration of risk terms thus seems to offer some new possibilities not only for increasing predictive power but also for increasing prior knowledge of the accuracy of predictions (based on estimation statistics for a more properly specified model).

Another important aspect of the risk-response studies of Behrman and Just should also be noted. In each case, the response equations were estimated for small agricultural areas. Behrman used changwads (approximately equivalent to counties), and Just used crop-reporting districts consisting of three to twelve counties each. There are perhaps two reasons why risk response has so far been shown of empirical importance only at a relatively disaggregated level. The first relates to narrowing the class of competing decision variables to manageable proportions so that the important interaction in risk response is estimable (i.e., so that degrees of freedom are sufficient to obtain statistical results). This factor was particularly important in the California study where so many crops are competing at the state level. The second reason for disaggregated estimation has to do with problems of aggregation in risk-responsive equations and pertains also to studies where interaction is unimportant. For expository purposes, consider two overly simplified response functions

$$y_i = a_0 + a_1x^*_i + a_2\,(x_i - x^*_i)^2, \qquad i = 1, 2,$$

where x^*_i is, say, the ith decision makers' weighted price mean over some lag period and x_i is his most recent price observation. The corresponding aggregate model would be

$$y = a^*_0 + a^*_1x^* + a^*_2\,(x - x^*)^2,$$

where $y = y_1 + y_2$, $x = (x_1 + x_2)/2$, and $x^* = (x^*_1 + x^*_2)/2$. In this case, no aggregation bias results in the traditional part of the model (where the aggregate lag distributions are averages of individual lag distributions) since $a^*_0 + a^*_1x^* = (a_0 + a_1x^*_1) + (a_0 +$

$a_1x^*_2$) for all x^*_1 and x^*_2 when $a^*_0 = 2a_0$ and $a^*_1 = 2a_1$. In the case of the risk term, however,

$$(2)\quad a^*_2\,(x - x^*)^2 = a^*_2\,(x_1 - x^*_1)^2/4 + a^*_2\,(x_2 - x^*_2)^2/4 + a^*_2\,(x_1 - x^*_1)\,(x_2 - x^*_2)/2.$$

Obviously, for general x_t and x^*_t,

$$a^*_2\,(x - x^*)^2 \neq a_2\,(x_1 - x^*_1)^2 + a_2\,(x_2 - x^*_2)^2$$

for any fixed a^*_2. In effect, the latter right-hand term in equation (2) introduces noise in the aggregate risk term which prevents accurate estimation of risk-term coefficients and biases the associated statistics toward insignificance. Nevertheless, it has been shown (as is partially intuitive above) that aggregation bias is small if observed errors ($x_t - x^*_t$) and response equation coefficients are near the same, respectively, over decision makers or if lag distributions are the same over decision makers and observations differ by constant amounts among decision makers (Just 1974a). In the case of both prices and yields, these conditions will likely be satisfied only for relatively small groups of decision makers with similar climatic conditions and enterprise alternatives such as are inherent in the Behrman and Just studies. But obviously it may also be advantageous to disaggregate by farm size, equity ratio, and other characteristics which affect behavior toward risk.

A Comparison of Positive and Normative Methodology

Although positive risk response models have only been estimated for specific annual cropping problems, recent work (Just 1974b) indicates that the same methodology has interesting optimal properties in a much broader class of problems. A similar framework can be used in both livestock and perennial cropping problems when lagged decision variables are included for all inputs which are partially determined because of decisions made in previous time periods. Technically, the explanatory variables which should be included in explaining each decision variable (in general) are all variables (prices, productivities, etc.) which together with the decision variables determine all the outcomes of interest to the decision maker (profit, sales, costs, debts, etc.). Under these conditions, the model in equation (1) with weights only slightly more general than the geometric ones defined above has been shown to be the optimal fixed coefficient (stable lag function) model when the explanatory variables follow a linear, Guassian-Markov process or are at least noisy observations of such a process. Although the explanatory variable assumption in this argument is rather specific, the objective criteria are essentially of full generality not requiring the existence of a utility function or of single-factored objective criteria. Furthermore, the results are of approximate applicability regardless of linearity and normality in the underlying economic environment so long as relevant ranges of the underlying explanatory variable process are approximated by linearity.

Although a similar generality can be attained in theory with programming or adaptive control theoretic problems, it seems unlikely that the normative approach to risk-response estimation can be applied in specific cases without requiring more limiting assumptions than the above positive methodology where objective criteria are concerned. Application of normative methodology also requires explicit specification of the production function. And unless a sufficiently general, decision theoretic programming model is employed, the formulation of producers' subjective distributions for prices and yields may still need specification—most likely with positive economic methods. However, if these obstacles can be removed, then the information from normative studies should also be useful for policy evaluation, and the arguments of Nerlove and Bachman indicating desirability of both positive and normative estimates would be applicable. Moreover, normative information should be particularly useful for evaluating policies which introduce new variables or constraints which cannot be represented in terms of historical controls and, hence, cannot be evaluated by positive methods until sufficient new data are generated. This possibility of drastic revisions in policy leads to the last point.

Policy Uncertainty

Three sources of risk and uncertainty deserve attention in agricultural problems: risk associated with environmental (and technological) factors such as weather, diseases, pests, and improved crop varieties and livestock breeds; risk associated with market factors such as supply in other exporting countries, export demand, input supply, and competing demand for inputs; and uncertainty with re-

spect to policy changes such as the form of government programs, the level of supports, and the regulation of pesticides and wastes. Thus far in this paper I have followed the profession in considering risk and uncertainty largely in terms of only the first two sources—environmental and market factors. But in an era of strict governmental controls and strong governmental influence, where policies are subject to quite drastic changes from time to time, uncertainty with respect to government programs may also have a considerable influence on producer decisions. It is not uncommon for several policy alternatives to be tossed around for quite a long period of time before one is finally chosen for implementation. My hypothesis is that this kind of uncertainty leads to considerable allocative inefficiency in the agricultural sector (as well as the rest of the economy) by creating a diversifying and lagged response to environmental and market factors. This would be especially true with respect to investment decisions. Perhaps if our models adequately reflected the effects of policy uncertainty, it would become clear that our policy changes should come in a more orderly fashion which would allow decision makers to plan ahead. It may be that changes should be instituted more gradually to allow for sufficient planning and efficient adjustment. In cases where the domestic economy is susceptible to drastic changes in foreign policy (such as with Russian wheat transactions), perhaps domestic policy should be designed at least to remove uncertainty with respect to foreign policy.

Some nonrisk-related research has already attempted to determine the need for controlled change in policy. For example, Rosine and Helmberger's work indicates that, because of lagged capital response, "an abrupt termination of farm programs during the decade of the sixties [1964] would have had a very serious impact on the welfare of farm families" (p. 726). However, with an adequate consideration of policy uncertainty, such studies may indicate an even greater cost. If farmers anticipate an abrupt policy change, then their organization will probably become more liquid before the policy change than would be efficient. These additional production inefficiencies due to lead capital response may also be important—particularly when anticipations are incorrect.

Evaluation of the effects of policy uncertainty indeed presents a difficult problem but one which should be considered. In some cases, such as with support levels, a risk-response model equation (1) may be adequate. But in many cases where new and untried alternatives are being considered, normative models may also be needed. Perhaps with both of these approaches the Delphi approach or a Bayesian approach of empirically determining subjective probabilities for alternatives will be needed to evaluate policy uncertainty. If this kind of information is compiled on a case-by-case basis and price and yield distributions can be determined under each policy alternative, then substitution into equation (1) should indicate some possible effects of policy uncertainty. But if decision makers' risk preferences can be determined, then a normative approach should also be useful since the continuous relationships usually used in equation (1) may provide poor approximations when policy alternatives differ drastically.

Conclusions

Risk response studies have so far been inadequate for meeting all our policy evaluation needs. Although the importance of risk preferences has been often acknowledged on the normative side at a microlevel, only a few positive studies of risk response have been forthcoming; aggregate normative estimates of risk response are extremely rare. Our literature abounds with normative models and methodology which decision makers can use in determining appropriate responses of all inputs, but so far only acreage response to changes in risk has been well documented empirically. An adequate consideration of risk responsiveness in all agricultural inputs, however, is apparently easily within reach of available methodology—at least with respect to environmental and market factors. Judging, in retrospect to past experience, it seems that some serious mistakes in policy formulation can be avoided if risk-responsive methodology is properly exploited. An evaluation of the effects of policy uncertainty, on the other hand, will be much more difficult but should be equally important in determining the manner in which policy changes should be made.

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Public Choice Theory: A New Approach to Institutional Economics

Vincent Ostrom

The primary preoccupation of public choice theory has been with nonmarket decision making and thus with public choice, not market choice. Economists recognize that market institutions have serious limitations and that an array of goods and services will be supplied through instrumentalities of government in one form or another. Unfortunately, institutions of government are also subject to institutional weaknesses and failures. Reliance upon governmental authority to correct for problems of market weakness need not lead to an improvement in welfare.

References to market institutions, to governmental institutions, and to problems of institutional weakness and failure suggest a preoccupation in public choice theory that is akin to the work of institutional economists. The kinship in interest is, however, accompanied by substantial disparity in method. Contemporary public choice theorists are more likely to be grounded in the microeconomic theory associated with the Chicago School than are the traditional institutional economists.

Whether public choice theory represents a major advance in institutional analysis will depend on whether it provides a new methodology for the comparative study of institutional arrangements. In examining its potential contribution to studying institutional arrangements, I shall focus on some of the basic elements in public choice theory: methodological individualism and the nature of goods as they relate to implications for institutional design.

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Methodological Individualism

Economic reasoning presumes all choices are made by individuals who weigh costs and benefits and choose those alternatives that will maximize their own net income or welfare potential. Methodological individualism implies that analysts rigorously and persistently use a language that comes back to individual persons as decision makers. The work of the earlier institutional economists would be criticized by many public choice theorists on the grounds that their use of language too frequently abandoned methodological individualism and painted sweeping word pictures of human societies as a whole.

The development of an analytical language that makes rigorous and persistent use of methodological individualism is plagued by two major difficulties. The first is that of stipulating a model of man that will provide an appropriate definitional referent in using individuals as the basic unit of analysis. The second difficulty is shifting the units and levels of analysis to take account of jointness of effort and interdependence of actions among aggregates of individuals.

Assumptions about Human Conduct

Homo sapiens through their use of language are endowed with a cultural inheritance that is variable in time and place. The information or knowledge that forms a part of this cultural inheritance significantly affects the opportunities and the strategic possibilities for choice available to individuals. Traditional assumptions about individuals as used in a theory of market choice cannot be applied as

easily to nonmarket decision making. Time horizons in constitutional decision making, for example, are radically different from the time horizons involved in market decisions. Problems of uncertainty, fallibility, and error will assume greater magnitudes. The acquisition of information will be a variable subject to economic calculations under conditions of uncertainty. Under such circumstances, learning and the generation of new knowledge become characteristics of individual human behavior which may transform the range of opportunities available and the way that preferences are ordered.

Assumptions of fallibility, uncertainty, and error proneness greatly restrict the rigor of deductive inference. Reasoned inference and conclusions are still possible as Tullock (1965) has demonstrated in his theory of bureaucracy based upon a simple set of assumptions about individuals seeking to advance career opportunities within a bureaucratic organization. Tullock derives loss-of-information and loss-of-control functions which enable him to generate conclusions about systematic tendencies toward goal displacement and "bureaucratic free enterprise" in large-scale bureaucratic structures. An assumption of perfect information would have precluded Tullock's development of a theory of bureaucracy.

Institutional Variables in Shifting Units and Levels of Analysis

While individuals may be regarded as the basic units in decision-making situations, they usually act within a social milieu that takes account of the interdependent interests and actions of other individuals. Market behavior involves individuals who function in production teams organized as business firms rather than individual proprietorships. If the firm manager is viewed as a single sovereign seeking to maximize profit, the assumptions applicable to individual conduct can be ascribed to the firm without too much difficulty. But to treat firms as though they were individuals obscures the problem of specifying the structure of authority relationships which both constrain some possibilities and create incentives to pursue other possibilities. These structures of authority relationships become the compositional or relational rules for transforming patterns of individual behavior into joint, interdependent relationships that take on characteristic patterns of organized social behavior. We would expect different relationships to exist, for example, in investor-owned firms than worker-owned firms even though each competes in the same product market.

Market conduct is organized by reference to specifiable rules of the game which can be stipulated in relation to the distribution of income, the structure of property rights, the terms and conditions for entering into binding contractual agreements, and the constraints that apply to unlawful conduct. These are the rules that establish terms of trade and specify limits to market relationships.

Patterns of authority relationships within the business firm may vary substantially from the relationships that are characteristic of market conduct. In turn, market conditions in a highly regulated monopoly structure will vary substantially from a highly competitive, open market arrangement. The structure of authority relationships both within the firm and within the product market represents two different simultaneous games which affect the conduct and performance in particular industries.

Specifying the structure of authority relationships for ordering social relationships requires explicit attention to institutional variables. Tullock's theory of bureaucracy specifies a set of institutional incentives and constraints that are quite different from those found in a market structure where individuals are free to trade with one another to each other's advantage. Instead, superiors were assumed to dominate the career opportunities for subordinates within a given organization.

Unless analysis is constrained by an arbitrary law and order assumption the specification of relevant institutional arrangements can become extraordinarily complex. The rules of a game within a team will be quite different from the rules of a game among teams. Whether those rules are effective in ordering conduct depends upon the availability of refereeing or enforcing arrangements. Unless those are assumed away, patterns of enforcement must be expressed in probability terms. We are confronted with the task of specifying interdependence among institutional structures on an assumption that a choice of strategy in one game can be viewed as a simultaneous move in a series of other games.

As public choice theorists focus upon nonmarket decision making, their success in positive analysis depends upon their capacity to specify rules and relationships which order

social behavior in specifiable ways. Presenting the logical implications of rules and relationships for specifiable units and levels of analysis is a major task. No single theory of teams or coalitions is appropriate to all decision-making arenas. The game of war, electoral politics, business competition, and adversary litigation involve quite different patterns of conflict, competition, and cooperation within and among teams.

By explicitly specifying the rules and relationships which facilitate and constrain the choice of strategy on the part of individual actors, public choice theory may be able to avoid models which differentiate economic man from organization man or political man. Instead we might anticipate why the same individual pursues different strategies by the structure of incentives created. Depending on the institutional setting the same individual may function as either an economic man, organization man, or political man. A general model of man can be used if the effect of institutional variables on the structure of opportunities and the choice of strategies in different units and levels of analysis can be explicitly identified.

If public choice theory can maintain a strong and explicit commitment to methodological individualism, specify the compositional and relational rules associated with joint efforts or teamwork, and specify the patterns of interaction that apply among teams in different decision-making arenas, we may be able to proceed step-by-step in the analysis of institutional behavior. We need to be quite explicit about the units and levels of analysis if we are to make comparisons where similarities and differences can be explicitly taken into account. Otherwise it becomes impossible to account for what differences institutional arrangements make in ordering social conduct and how these patterns of conduct affect the well-being of those who function in different institutional structures.

The Nature of Goods

Perhaps the most important element in public choice theory has been an explicit effort to identify characteristics of goods which are associated with differential institutional arrangements. The task has been one of differentiating marketable goods and services from those which are not subject to market provision and require recourse to nonmarket institutions to secure their provision. The degree of success or failure will probably be the critical factor in establishing the net contribution of public choice theory to institutional analysis.

Economists have long identified exclusion as an essential condition of market organization and the absence of exclusion as a condition evoking market failure. Jointness of use, nonsubtractability of consumption, measurability of outputs, and durability of a good or service are some of the other attributes, apart from exclusion, that help to distinguish the nature of goods and services.

Exclusion implies that a vendor can deny a potential buyer the use of a good or service. Jointness of use implies that a number of individuals will simultaneously enjoy the benefits or endure the costs that are associated with some set of events which can be conceptualized either as a "good" or as a "bad." On the basis of these two considerations—jointness of use and exclusion—a provisional definition of a public good or service is one that is subject to jointness of use where exclusion is difficult or costly to attain (Olson 1965; Mishan).

Jointness of use or consumption does not foreclose the possibility that partial exclusion can be attained for some goods and services. A theatrical production is jointly enjoyed by an audience but exclusion can be attained in admitting only those who pay a price for admission. The same principle can apply to toll roads and to jointly used goods or services subject to user charges. My colleague, Elinor Ostrom, has referred to such goods as toll goods. Toll goods typically involve an element of choice for the potential user as against a no-choice circumstance that may apply to individuals in many public-good situations.

Where jointness of consumption occurs and exclusion cannot be attained, an open question remains about the magnitude of the effects associated with events that can be identified as a potential public good or service. Boundary conditions characteristic of such events may be more or less precise or ambiguous. The boundary conditions that apply to watersheds, for example, are easier to establish than boundary conditions for atmospheres or microclimates. Man-made conditions such as the provision of law and order, the aesthetic quality of an urban landscape, or other types of public goods and services may be differentiable over a larger domain but subject to

an undifferentiated jointness of use within a smaller domain. So long as the Tiebout option is available, the choice of a residence among differentiated neighborhoods may be similar to an admission charge for a toll good. Where boundary conditions can be differentiated so that beneficiaries can be included and nonbeneficiaries excluded, a weak form of exclusion can be introduced into the organization of a public economy.

Another characteristic of events which is treated as a good or service is whether use or consumption by one individual exhausts the utility of a good and precludes its use or consumption by other individuals. The definition of consumption in market economics is usually based upon a stipulation that consumption by one precludes consumption by others. Samuelson's initial efforts to conceptualize a public good turned critically upon nonsubtractibility of consumption. A public good is one where consumption by one does not subtract from its consumption by others. The marginal cost of the additional consumer is negligible or zero. Each individual has equal access to the use of a public good.

These conditions may apply within thresholds but the case of a purely public good characterized by complete nonsubtractibility of consumption is difficult to imagine. J. H. Dales, for example, has commented that gravity is the only case of a purely public good that he can identify. Perfect nonsubtractibility in consumption may imply that no effort need be made to secure such a purely public good.

The disconcerting problem for a public economy is where jointness of consumption occurs under conditions of partial subtractibility. At some threshold of supply, use by an additional person or for an alternative type of use may impair the value of the good for other users or alternative types of users. The condition of partial subtractibility when aggregate demands exceed the threshold of supply can lead to an erosion or degradation in the quality of a public good. Conditions of partial subtractibility imply that jointness of use gives rise to potential conflict as among patterns of use. The resulting impairment of use generates pollution, congestion, or an erosion in the qualities of life (Buchanan and Tullock 1970).

These characteristics of public-good situations might be extended by a consideration of measurability, durability, and other similar characteristics. When consumption of a service occurs simultaneously with its production, it is difficult to differentiate an output or a product from the production process itself. Monitoring the performance of those who supply police services, for example, poses difficulties because of the nondurability of the service and the problems of measuring the output.

Public choice theory has only begun to cope with the essential problems of characterizing the nature of goods. Ideal formulations for specifying purely private and purely public goods are likely to apply only to a few trivial cases. Instead we might view attributes such as exclusion, jointness of use, domain, subtractibility of consumption, measurability, durability, and other such characteristics as variables. Goods could then be placed on a continuum between purely private and purely public. The presence or absence of certain attributes or characteristics might be viewed as creating opportunities or posing problems that are subject to variable solutions. Despite its limitations public choice theory, viewed in this way, has important implications for the design of nonmarket institutional arrangements in a public economy.

Implications for Institutional Design

Olson (1965) indicates that where a public good is subject to joint consumption and where exclusion cannot be attained, we can anticipate the failure of a solution that depends entirely upon voluntary agreement among the individuals involved. Each individual within the relevant domain will, by definition, be able to enjoy the benefit of whatever good is secured by natural provision or by the efforts of others. If expenditures are required to modify the supply of such a good, some individuals will have an incentive to take advantage of whatever is freely available and to minimize costs by withholding his own contribution to the joint efforts. Unless the community of beneficiaries is sufficiently small to be able to coerce one another and to keep account of each other's contribution to the common good, individuals will have an incentive to follow the example of successful holdouts and an unsatisfactory supply of public services will be provided.

Given the probability that purely voluntary efforts to supply a public good will fail, rational individuals would search out nonvoluntary solutions which would enable potential

beneficiaries to procure a joint good while minimizing their potential costs. Assuming that public goods come in different sizes and shapes, Olson has formulated a "principle of fiscal equivalence" to indicate that the boundaries of a jurisdiction to procure a public good or service should be drawn so that potential benefits and costs for the potential users can be internalized (Olson 1969). If appropriate boundaries are drawn, if the assessment costs are proportioned to benefits received, and if benefits exceed costs, each individual would have an incentive to support an arrangement where each individual is coerced to pay for his fair share of the joint effort.

Buchanan and Tullock (1962) have developed a cost calculus that can be used to conceptualize the problem of constitutional choice in organizing a collective to provide a public good. The choice of constitutional decision rules would stipulate the conditions that would apply to enforceable collective decisions so that expected interdependency costs would be minimized in relation to the net benefit to be derived from the provision of a public good.

A whole series of problems in the constitution of a collective enterprise to procure the supply of a public good can be delineated. The domain of the good needs to be related to the territoriality of jurisdiction. The particular type of good needs to be related to the scope of jurisdiction. Powers of taxation and eminent domain are required to solve the holdout problem. In the presence of coerced pricing and relaxation of the rule of unanimity, alternative decision-making mechanisms are needed to articulate user preferences and to aggregate those preferences into collective decisions about the quantity and/or quality of the public good to be provided.

The essential difficulty in dealing with public goods is jointness of consumption where the failure of exclusion permits potential holdouts. The essential problem occurs in organizing the consumption side of economic relationships (Ostrom, Tiebout, and Warren; Bish; Bish and Ostrom). Establishing conditions of territoriality, scope of jurisdiction, taxation, voting, representation, and aggregate decision-making authority and the capacity to authorize provision for a given quantity or quality of public service are all aspects that bear upon collective consumption functions.

Any collectivity organized to perform collective consumption functions faces an independent question of how to arrange for the production and delivery of a public good. Among the options are the development of its own production team to supply the service through its own production efforts, a contract with an independent producer, who might be private vendors or another public agency, or a combination of both possibilities.

By distinguishing collective consumption units from production units it is possible to anticipate the quasi-market conditions in the relationships among the different units of a public economy created by the contractual arrangements among collective consumption units and independent production units and by competitive rivalry among potential producers (Ostrom, Tiebout, and Warren; Bish; Bish and Ostrom). Scale conditions that apply to the organization of collective consumption units may vary radically from those that apply to production units. A user of interstate highways, for example, might gain an advantage in acting through a national government as the most appropriate collective consumption unit. It is an independent question as to what size of unit is most efficient in building and maintaining interstate highways.

Multiple agencies, fragmentation of authority, and overlapping jurisdictions may be more responsive to diverse preferences and supply services more effectively than where a fully integrated unit of government becomes the sole supplier of public goods and services. In the absence of enlightened and benevolent leadership we might also expect public monopolists to be as self-serving as private monopolists.

The essential point is that public choice theory enables us to derive quite different solutions to the problem of public sector organization than have been derived from the traditional principles of administration. The application of economic reasoning to nonmarket decision making has in effect provoked a paradigmatic challenge to those fields of scholarship (public administration and political science) which have been centrally preoccupied with nonmarket decision making (Tullock 1970; V. Ostrom 1974).

Where we have theories that lead to contradictory conclusions, the choice of theory to guide future work depends critically upon whether evidence consistently supports one or another contention. Work in public choice theory must now be complemented by empirical investigations where contending hypoth-

eses can be tested for their predictive value (E. Ostrom; E. Ostrom and Parks; E. Ostrom et al.).

Problems associated with the so-called urban crisis, with crime in the streets, with the performance of local government services more generally, and with the contemporary constitutional crisis over executive authority may all have been exacerbated by inappropriate reform and reorganization efforts over the past several decades. The challenge inherent in public choice theory may also lead to a basic reassessment of the implications following from these past political reform and reorganization efforts (Bish and Ostrom). A positive theory of public choice is a necessary condition which will evoke the intended consequences. Otherwise, reasoned choice cannot be used to inform political decisions.

Public choice theory also provides a basic link in going beyond twentieth-century scholarship and rediscovering the use of methodological individualism and economic reasoning in seventeenth-, eighteenth-, and nineteenth-century political thought. The work of Thomas Hobbes, for example, is thoroughly grounded in methodological individualism and uses economic reasoning to consider the problem of constitutional choice. Alexander Hamilton, John Jay, and James Madison draw upon the same theoretical foundations to derive quite different solutions (V. Ostrom 1971). In some ways Hamilton and Madison go well beyond Buchanan and Tullock in conceptualizing the conditions necessary for the maintenance of an enforceable system of constitutional law. Hobbes had considered the maintenance of an enforceable system of constitutional law to be a logical impossibility or absurdity. Alexis de Tocqueville relies upon the same methods of economic reasoning to conduct his comparative analysis of institutional arrangements in France and the United States (1945, 1955).

Public choice theory thus provides a major paradigmatic challenge to twentieth-century scholarship concerned with the study of government and public administration; it provides a link to much earlier studies of political economy before economists became preoccupied with market structures and political scientists became preoccupied with governments. If we can combine both the old and the new, we may have the elements for an institutional economics that lays the foundations both for a positive analysis of human institutions and for the design of human institutions on the basis of reasoned choice.

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Public Choice and the Quality of Life: Research Processes and Problems in Nonpecuniary Economics

James Hite

In examining the processes and problems of researching a public choice theme, it is well to begin by noting that the fundamental concept of all recent public choice theory is application of the Benthamite motivational model of utility-maximizing individuals to analysis of human choice in nonmarket settings (Buchanan pp. 16–18). It is assumed that if utility maximization is a valid premise upon which to analyze marketplace choices, it is an equally valid one for analysis of other kinds of choices. Fidelity to the Benthamite model deserves emphasis, for if public choice research cannot be rooted solidly in utility theory, the economist finds himself with little to offer beyond the scope of the simple financial analysis which might better be done by an accountant.

Yet the prototype Benthamite model used by economists is an unsophisticated contraption, limited to analysis of choices where all relevant utility-producing factors are somehow measurable in pecuniary terms. To make a meaningful contribution to the analysis of public choice questions we need a more powerful and versatile model, Benthamite in concept, but capable of admitting a wider range of utility-maximizing factors without excluding the traditional pecuniary elements. In short, we need an operational quality of life (QOL) model. The extraordinary importance of the QOL concept to practical, applied public choice research is not to be underestimated. It is an important analogue to that of the concept of utility to understanding of consumer behavior. Our sophistication in public choice research is likely to be no greater than the sophistication with which we understand the full meaning of QOL.

If a practical, positive, and rigorous QOL model were a straight-forward undertaking, we might well suppose that one would have already been forthcoming. Indeed, there is no dearth of literature on the QOL concept (Castle; Cebula 1974b, 1974c; Cebula and Vedder; Liu 1975, forthcoming; Smith). But that literature is dominated by noneconomists, and, for the most part, is normative in nature. The only hint of a logically positive, utility-oriented QOL model is suggested in some empirical work reported by Cebula (Cebula 1974b, p. 85; Cebula 1974a; Cebula and Vedder). Cebula's theoretical rationale is drawn from a well-known article in which Tiebout makes the argument that migration patterns represent a kind of spatial revealed preference for public goods (p. 418). Of course, there are assumptions which qualify Tiebout's argument (e.g., perfect mobility, perfect knowledge, large number of different kinds of communities, etc.). But Tiebout concludes that migration may produce allocations of public goods at least as nearly optimal as that of market goods, given the imperfections which confound the working of the perfectly competitive model in the marketplace (pp. 419–24).

Taken to its logical conclusion, the Tiebout adaptation of utility theory suggests that if an individual is free to choose the location at which he will live among all possible locations (each of which represents a unique combination of QOL factors) and if the individual is assumed to be a utility-maximizer (given his finite and imperfect knowledge), he will choose to live at the location where the combination of all factors provides him with the maximum obtainable QOL at any given point in time. The individual may not find everything at the location to be optimal, given his preference set. Trade-offs are made between pecuniary, social, cultural, and environmental factors. Yet when the individual chooses a particular location, it must be because he con-

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siders the trade-offs he would be required to make in relocating to reduce his total utility. All locations not chosen are revealed inferior in the utility, the QOL, they offer to that individual.[1] What we have therefore, is a spatial revealed preference model, analogous to the Samuelson-Hicks model, which can allow us to draw inferences from observed behavior and generate refutable hypotheses in the tradition of positive economics.[2]

Quality of Life Hypotheses

Even those who may wish to exercise reserve in embracing the Tiebout argument at its logical extreme will, I have little doubt, concede that migration is some expression of preference for the attributes of one place over another, or, at the very least, some expression of rejection of the attributes of the place left in favor of the uncertainty of the place to which the migrant moves. Hence, one has a right to expect some relationship between migration patterns, as revealed by the Census of Population, and the various QOL indexes which are proposed. The two most recent and comprehensive sets of such indexes are those developed by Liu (1975) and Smith (p. 96).

The indexes provide an opportunity for testing some hypotheses deduced from the Tiebout spatial revealed preference model. Accordingly, I have attempted to test two alternative sets of null hypotheses: (*a*) there is no inverse correlation between states' rate of out-migration (1965–70) and QOL indexes; and (*b*) there is no direct correlation between the states' rate of in-migration (1965–70) and QOL indexes. In performing the tests, the migration rates were disaggregated by age and race, using the 15% sample data reported in the 1970 census and a correlation coefficients matrix was calculated.[3]

The correlation coefficients matrix is not reproduced here in the interests of space. An examination of its elements, however, shows that the best case for rejecting any of the null hypotheses presented above can be made for Liu's QOL index as it relates to in-migration of Negroes. The rates of in-migration of Negroes are highest for those states which Liu's index also shows to have the highest QOL. A similar pattern, albeit with a lower level of statistical significance, can be observed for Smith's QOL measure. The tests are much less conclusive when applied to out-migration rates for Negroes, revealing significant inverse correlation only between the Liu index and the 20–24 age bracket and between the Smith index and both the 20–24 and 25–29 age brackets. There is statistically significant evidence of direct correlation between Liu's index and in-migration of whites in the 25–29 and 30–34 age brackets but no such evidence at all relative to white in-migration and Smith's index. The correlation coefficients for white out-migration and the two QOL indexes are all positive although, with a few exceptions, not statistically significant. At least for the age brackets in which correlations are of statistical significance, it would appear that the paradox exists wherein the higher QOL, as measured by Liu and Smith, the greater the rate of white out-migration.[4]

Thus, we are left with two proposed QOL indexes which are generally consistent with Tiebout's spatial revealed preference model only for Negro citizens. And even at that, given the lack of sensitivity to out-migration, these indexes would appear to be better adapted to measuring what is good QOL than what is not so good. Do we reject the Tiebout model, and with it, utility theory and logical positivism? Such a rejection would seem to be required if we are to accept the QOL measures proposed by Liu and Smith. Or do we look critically at such QOL measures? We must do one or the other, for if we attempt to hold on to logical positivism while embracing the Liu and Smith indexes, we will be forced to conclude that young blacks are the only segment of our population capable of accurately perceiving and responding to better QOL.

Normative Concepts and Positive Science

That the revealed preferences for QOL attributes of different groups in the population will be quite different should be easily understood by economists. Like utility (of which it is part

[1] Indeed, Tiebout argues that "there is no way in which the consumer can avoid revealing his preferences in a spatial economy" (p. 422).

[2] Those who find the Tiebout model unorthodox and radical may want to consider that a similar idea underlies much of the recent work aimed at using land, or property, values to determine the damages due to air pollution. Note, however, no claim is made that the Tiebout model lends itself to analysis of changes in QOL over time; its validity is clearly limited to analysis of relative QOL over space.

[3] Tests were also made using net migration data and in- and out-migration data, but the results were similar to those discussed here.

[4] Correlation coefficient between Liu and Smith QOL indexes is 0.83806, significant at $\alpha = 0.01$.

and parcel), QOL is a highly personal concept which, although normative in its connotations, is quite capable of being examined without resorting to normative premises. There is ample evidence in earlier studies that the factors influencing migration by blacks and whites are different—if not in kind, at least in degree (Trott, pp. 204–209). Therefore, it follows that if migration represents a revealing of preferences for spatial aspects of QOL, no one QOL index (or set of indexes highly correlated with each other) is acceptable for public choice analysis. It is because of this diversity of preference sets, this n-dimensional matrix of QOL indexes, that public choices require trade-offs between various segments of the population and that public policy decisions have both efficiency and distributional ramifications. To collapse the QOL matrix into one or two vectors of indexes on the basis of some normative doctrines, conjectures, or judgments concerning social goals (as is the case of the Liu and Smith indexes) is to avoid the most critical issues that public choice researchers need to address.

The normative problem is one which is especially bothersome in public choice research because of the pervasive intrusion of ethical concepts into the rhetoric of public policy debate (see Buchanan, p. 17). The idea of "quality," be it QOL or quality of some agricultural commodity, is almost by necessity a normative one. Castle reminds us that QOL is associated with environmental quality (p. 723) and there is considerable empirical evidence to support the contention that, at least in the case of environmental quality, perceptions of what is and is not desirable are influenced by socioeconomic status and cultural background (Hall, pp. 363–64).

Both Liu and Smith readily admit the normative basis which underlies their work. In the case of Liu, the criteria considered in arriving at the QOL index were derived from the Report of the President's Commission on National Goals (p. 2). The Smith study reflects the same normative judgments, based largely on work of sociologists, and is subject to the same problems inherent in Liu's work (pp. 66–70). In all fairness to both Liu and Smith, each gives explicit recognition to this problem. Yet these normative judgments about what constitutes better and better QOL may explain the inconsistencies between the Liu and Smith QOL indexes and observed migration patterns.

These inconsistencies may also be a symptom of an improper delineation of the spatial unit of analysis, that is, it is at least plausibly arguable that QOL indexes calculated by states as geographical entities are too gross. By almost any criteria, QOL is not likely to be homogeneous within a given state. Consequently, QOL indexes and migration patterns examined at the state level may not reveal important intrastate differences. For example, if one part of the state has high in-migration and low out-migration rates, the overall state migration patterns will not be particularly meaningful. It is important to consider just what level of regionalization is appropriate for QOL analysis or any other type of public choice research (Lovingood and McKay, pp. 1–2, 14–16). If we cannot observe the right phenomena at the right level of observation, we cannot inject logical positivism into public choice research. Yet, even when it is possible to determine the proper level of regionalization, data problems often preclude useful analysis. Perhaps these data problems are responsible, in part, for the normative approach to QOL analysis. But they are not inherent in, or even unique to, public choice research. To abandon the assumption of rational, utility-maximizing individuals and a research methodology premised upon logical positivism is to discard the human insights and scientific objectivity which are the intellectual foundations of economics. There is another alternative; i.e., attack the data problems honestly, and with some daring, by more specifically defining the data that are required and attempting to influence data-gathering agencies to routinely collect such data.

Conclusions

In conclusion, it may be said by some that this paper is unnecessarily preoccupied with researching measurement of the quality of life, that it somehow implies an identity between QOL research and all public choice research. Such an implication is not intended, but the profound significance of the QOL concept to a host of public choice problems should be stressed. The implications of the QOL concept for enriching benefit-cost analysis by broadening its scope to include nonpecuniary distributional considerations are enormous, as are its implications for more searching studies

of voter behavior. The QOL concept can free economics from its almost exclusive pursuit of values which cast pecuniary shadows.

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Extension of Public Choice Ideas: A Reexamination of Professional Lore

Edward Lutz

In discussing extension of public choice ideas, it is helpful to reflect upon experience in extending ideas to the traditional farm clientele. Effective agricultural extension education has required two things of those conducting it. First, they must have command of the subject matter that will interest their clientele. Second, they must know their clientele well enough to understand what subject matter will elicit interest and concern. Knowledge by the teacher of both the subject and those being taught is probably a necessity for effective formal education generally, but I focus here upon particular kinds of education on which I have been asked to discourse.

How important and inseparable these two requirements are—knowledge of subject matter and of constituency—became much clearer than heretofore in the years after World War II when we first tried on a large scale to export agricultural technology to poor nations seeking economic development. Extension workers from the United States found great gaps in available knowledge applicable to problems and concerns of the intended farm clientele. They also knew too little of their foreign constituency.

They discovered further that development required more complex changes in the economy than giving advice to farmers on how to increase yields and income. The changes were somewhat comparable to those that had occurred in the United States beyond the farm and were by and large regarded in the United States as beyond the realm of extension, such as in improving farm credit, building roads and transportation systems, improving communications technology, opening marketing channels, developing electric power, providing elementary education, raising rural health standards, and so on. These examples also suggest the current difficulties which land grant college research and extension personnel encounter in their attempts to improve "rural community services." These examples furthermore emphasize the importance of public sector policies, institutions, and processes in rural development, including agricultural development.

Rural Development Extension Clientele

Thus, in relation to rural development extension, the necessity of knowing subject matter and constituency reaches widely into the public sector. It seems sensible therefore to include among clientele the decision makers in the public sector.

Much printers' ink has been committed to the question of who really makes public decisions, with common allusion to smoke-filled rooms, power structures, and the low state of intelligence, morality, and incorruptibility among public officials. Extension work in farming probably never would have begun if there had been comparable concern over whether capable, upright, independent individuals really run the farms. One way of identifying public decision makers may seem overly naive to the more sophisticated, but it is simply to consult the laws and customs in these matters. Such study reveals that in addition to occupants of the White House Oval Room, there are literally tens of thousands of public decision makers in the United States in federal, state, and local governments, and their legislatures, executive agencies, and judiciary.

Economists as Reformers of Public Administration

Many agricultural economists and others find it difficult to recognize this fragmented army of individuals as public pathfinders. The persistent image of the United States as a neatly ordered pyramid of power and authority, or a series of dovetailed pyramids, results in a

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curious blind spot. Many would readily agree that duplication, overlap, and competition among food stores, farms, and other private sector activities commonly found in a community are economically desirable in the name of efficiency, least cost, and responsiveness to consumer demand. At the same time in the public sector, duplication, fragmentation, overlap, and so on are regarded as undesirable for the same ends. The recent Task Force Report to the Northeastern Regional Agricultural Research Planning Committee, in discussing rural development research and in recommending attention to local government and finance, includes the usual inferences about antiquated local governments being too small to render efficient services (p. 15).

This implicit assumption about the desirability of abolishing and combining many local governments into one for efficient service to consumers is by no means unique to agricultural economists (Ostrom 1973, 1974; Bish and Ostrom). The Committee for Economic Development, for example, a few years ago proposed a reduction of 80% in their number (p. 17). The prevalence of this idea, however, blinds many interested in extension in rural development to the desirability of knowing and understanding a considerable portion of the potential decision-making clientele, the local public officials. The idea also affects conceptions of subject matter that concerns clientele. The situation resembles one that might have developed earlier in this century if extension workers in farm management had concluded that 80% of the farms should be abolished or consolidated in the name of efficient food service to consumers and that therefore they should direct their professional efforts toward consumer leaders to bring about this result.

In extension work where clientele is defined as including local officials with their problems and concerns, the standard professional prescription of elimination of antique local governments is not only not what is wanted; it is a normative remedy buttressed most of the time by the shakiest of empirical observation and is therefore academically questionable.

New York Allusions with Apologies

To help understand the New York effort in public choice extension let me trace a few developments in that state that seem influenced by the traditional reform model of public administration.

We in New York have gone a long way, but not the whole distance, in adopting this model by degrees over a long period. The ideas arose in early decades of this century in a sense from "out of the times." Political scientist Elazar attributes the movement partly to reformers, influenced by big business organization of an earlier generation (p. 474). Vincent Ostrom traces intellectual origins to Woodrow Wilson's writings of the late nineteenth century (1973, pp. 23–47). In either case, New York City was a principal center of the reformer ferment, and the influence extended to the state capitol and beyond.

Successive political leaders sought to conform the state's executive branch more closely with the reform standard of the hierarchical pyramid of authority, the early figures including Governors Charles Evans Hughes and Al Smith. Currently, the state's executive bureaucracy is eclipsed in size by none, possibly excepting California. The state is probably not exceeded in volume and detail of legislative output or laws nor in degree of state administrative oversight over both public and private concerns.

Among metropolitan consolidations, by far the largest in the nation has been that of the Greater City of New York in 1898. City boundaries surrounded an area where eight million people now live, more than double the population of the next largest American city (Chicago), and where there were at the time all or parts of five counties, three cities, nine villages, and thirteen towns. By successive charter revisions and other moves, the city organization has been made to conform more closely to the reform model until recent years when there have been second thoughts about more neighborhood control but also sentiment for additional metropolitan expansion.

Notwithstanding these developments in the state and great city, almost all local governments in "upstate," or the rest of the state, have survived, with the outstanding exception of school districts where wholesale consolidation has occurred over a half century. Everywhere in rural New York is a minimum of three "layers" of local government—county, town or city, and school district plus, possibly, village or fire district and other units. Even in this populous state, almost one-third of the counties have fewer than 50,000 residents; about one-fifth of the towns (town-

ships) and one-third of the villages have fewer than 1,000. At the lower extreme is a town of fifty-eight people and a village of twenty-four according to the last census.

By the reform standard, one might say that New York has a fairly modernized state government and an ultra-modern New York City. Elsewhere in the state are local governments of varying degrees of antiquity, except for school districts and a few modernized county organizations, generally in the more populous areas. For decades local governments beyond the great city in upstate have been subject to browbeating with the reform prescription. The gulf separating the city and upstate in matters governmental stems partly from differences in the seriousness with which the doctrine has been taken. A denizen of Brooklyn cannot understand the chaotic, fragmented, overlapping upstate local government. The upstater in his turn points to the monolithic city organization, made lethargic if not impotent with its layers of bureaucracy.

The public choice paradigm offers opportunity to students and decision makers, both upstate and down, to break out of an intellectual mold that has come to freeze flexibility and creativity in providing and financing public services for the citizen-consumer-taxpayer. The widespread and often unthoughtful acceptance of the traditional reform model has driven the state, the city, and other local governments into a kind of mental dead end. Having already erected huge bureaucratic pyramids of authority, they continue to encounter seemingly insuperable public service problems. The remedy indicated is still larger and more encompassing pyramids. The ultimate is one pyramid which internalizes all the externalities as perhaps it did in the reigns of the Egyptian pyramid builders and as the marbled halls in Albany now seem to promise as they loom like the towers of Xanadu. This allusion to Coleridge gains force from his observation, "Every reform, however necessary, will by weak minds be carried to an excess, which will itself need reforming" (p. 26).

The Public Choice School

The public choice school, with origins perhaps fifteen years old, questions the traditional reform model. It seeks to replace the prescriptive principles of public administration with predictive propositions that can be and are being researched to test their validity (Ostrom 1974). The school starts with the individual as the basic unit of analysis—the individual as consumer of public services and goods, as taxpayer, as public official, bureaucrat, citizen—not with the society or nation or community. It makes assumptions about individuals that are familiar to economists—the scarcity of goods and services, self-interest and individual rationality in using scarce resources (Bish 1973, p. 3). It considers supply of public services and demand for them as separable both in theory and practice.

Thus, a government to and through which citizen demand is expressed often procures the services demanded without necessarily producing them itself; it acts as a kind of purchasing agent for its constituency. A small government may contract with a larger one or with a private concern for a service it cannot perform economically itself. Likewise, larger governments contract with smaller ones to get things done.

This school finds purpose and utility in the diversity of kinds of governments and public organizations found in the United States. Wholesale local consolidation and the search for economies of scale through large operations under centralized direction are not central considerations. Rather, emphasis is placed on how to reconcile a diversity of individual preferences for a diversity of public services and goods through a diversity of organizational or decision-making arrangements (N.Y. State 1974–75, p. 4). The proposition that bigger is better is not a self-evident truth chiseled in granite. Rather, when a specific public service is identified, when consumer demand or satisfaction is measured, and when productivity in supplying the service is identified, the proposition becomes researchable. Elinor Ostrom and her associates have done notable research, for example, on the relation of scale of organization to police patrol services (Ostrom and Smith).

Extension and Public Choice

An important purpose of including an introduction to the public choice school thinking in extension work in New York has been to help free the minds of community public decision makers from the mental confinement of regarding the reform model of public administration as the only basis for considering how to

perform efficiently essential public services. The aim has been not to defend the status quo but to refresh and excite imaginations in tackling public concerns with a viewpoint of American government that has coherence and a rationale.

The extension of public choice ideas is only now being tried (Bish and Ostrom). It consists of a highly condensed summary of recent writings in one of a series of five leaflets published under the common heading of *Shibboleths—True or False?* The leaflets provide a basis for a series of informal discussions by small groups of legislators serving on local town, village, city, county, school district governing boards. County extension agents are asking local legislators and other community leaders to join these informal groups. It is too early to know how widespread interest may be over the state, but presumably several thousand individuals will be engaged in the groups within the next year, including an interested minority among an estimated 10,000–13,000 local legislators. The leaflet on public choice ideas is entitled "Restructuring Local Government: Is Bigger Better?" Other leaflets are intended to stimulate discussion of community control of local finance, economic growth, and information for local decision making.

This *Shibboleths* effort stems in part from the longstanding association of several individuals at Cornell with public decision makers and administrators. Extension explicitly for local officials goes back more than thirty-five years. In-service training of this kind took a more intensive turn in the late 1960s with federal and state financial support; more recently it has blossomed into the Cornell Local Government Program.

Recent expansion of these extension efforts has been directed to two groups of local public officials and employees: supervisory and managerial personnel in the "executive branch" and local legislators who are typically part-time representatives on governing boards with substantial powers over policy and finance.

We started the recent expansion with a survey of training needs sent to a large sample of the two groups. The survey is part of the perennial task of defining and understanding clientele and subject matter. Several hundred local legislators responded. They indicated interest in their legal powers and duties (perhaps not surprisingly), matters of budget and finance, local government problems and trends, and other items in lesser degree. We have prepared publications and conducted local training sessions on powers and duties, budget matters, and other things (N.Y. State 1974). The *Shibboleths* discussion series is a major part of a beginning in education in local public problems in response to the survey findings.

The possibilities of extension education and research in public choice have been barely touched in relation to practical questions of rural development.

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Public Choice, Agricultural Economics, and the Public Sector: A Public Sector Consumer's View

Victor L. Arnold

Those of us who, as a matter of choice, decide to spend part of our professional lives in institutions of higher education and part in the public sector like to think we have a unique career opportunity. In the academic world we can devote our efforts to the development of public choice theory. In the public sector we can assist in applying, testing, and perhaps rethinking the applicability of the theory to public choice issues.

It is a pleasure to be invited to share with the agricultural economics profession my view of public choice issues from my present role as a public sector consumer of public choice theory and methodology. Under a time and space constraint I have attempted to maximize the number of issues presented in hopes of portraying a variety of challenges and opportunities to agricultural economists who are interested or currently engaged in public choice. The issues are: the application of existing marginal analysis theory to public policy and expenditure issues at the state and local level, the need for a new theory of public goods and services, and the need for effective institutions for citizen participation in public planning and decision making.

Application of Marginal Analysis to Public Policy Decisions at the State and Local Level

As government at all levels becomes more sophisticated in its view and approach to public choice issues, simplistic dichotomies of public decision-making processes become less clear.[1] The decision process has become a fusion of political, bureaucratic, and rational decision processes. It may be that the failure to recognize this fusion has caused the reluctance by many economists to engage in the application of marginal analysis to public choice issues for fear of being castigated as being normative. Such timidness is largely unwarranted because the rational component is generally about one-third of the total decision process. It is a component, however, which deserves more attention and the best information which can be brought to bear.

There are a number of current and future public choice issues which emerge from applied demography that need attention by economists. My examples are from Minnesota, but I believe they are illustrative for the rest of the nation.

Population migration from rural areas to urban areas which was prevalent in the 1950s and 1960s appears to have stopped and early indications are that the trend has reversed. In Minnesota, the 1970 census indicated that since 1960, forty-four out of eighty-seven counties lost population, due largely to out-migration to urban areas. The total state population increased (U.S. Department of Commerce 1973, pp. 20–21). The state and federal 1974 population estimates, however, indicate that seventy counties have populations larger than the 1970 levels, due largely to in-migration (Minnesota Office of the State Demographer, U.S. Department of Commerce 1975, pp. 3–4). Since 1970, 76% of all new and expanded manufacturing employment has oc-

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The points of view expressed by the author in this paper should not be considered to be the policy or opinion of the State of Minnesota or any Minnesota political incumbent. They are those of the author and he accepts sole responsibility for error or omission.

The author would like to publicly thank as well as apologize to Daniel Bell for influencing the author's thinking on matters of public choice more than he should have or more than he would have liked to.

[1] As Allison points out, one dichotomy of the public decision process is that decisions are political. Political benefits and costs of any course of action or decision are identified and weighed. The alternative with the least political cost is the preferred course of action or decision. Another dichotomy is that the decision process is bureaucratic and follows standard operating procedures. A third is that the rational decision process is based on economic theory. This process identifies the marginal economic benefits and costs of alternatives and decisions based on the maximization of benefits over costs.

curred outside of the seven-county metropolitan area of Minneapolis–St. Paul (Minnesota Department of Economic Development, p. 11). Some of the important policy and expenditure issues faced by state and local governments when confronted with counties and communities with declining populations and an increasing incidence of residual elderly population are the effectiveness of public expenditures and tax policy in reducing or stabilizing population out-migration, alternative means to provide health care, education, and other human services, and the impacts of alternative transportation policies on county and community capital infrastructures.

States, counties, and communities when confronted with population growth are increasingly sensitive to the pecuniary and environmental costs of growth. Additional and new work is needed to assist government in determining these costs and allocating the cost burden.

Demographic data also indicates that the post–World War II baby boom is entering the labor force. Projections based on using 1970 census data, with some assumptions regarding mortality, migration, and labor participation rates, indicate that Minnesota will need approximately 510,000 more employment opportunities by 1990 (U.S. Department of Commerce 1973). This is probably a conservative estimate because the female labor participation rate was assumed to remain stable. These projections portend an annual rate of increase in employment opportunity greater than any rate of increase in the past. The new employment opportunities will have to be generated subject to constrained energy and mineral resource supplies, increased substitution of capital for labor, the uncertain future of the private sector's ability to generate capital, and a long overdue public concern for environmental amenities. Do we want the continuance of a trend toward a postindustrial society with increased employment in the service and government sectors or do we want a more balanced distribution of employment among sectors? The implications of questions such as this must be subjected to analysis.

The list of public choice issues could go on to include the impact of a declining birth rate on elementary, secondary, and postsecondary education, the impact of new federalism on state and local intergovernmental relationships, and alternative means to generate and distribute state and local revenues. However, there is increasing need and opportunity for applied marginal analysis in the public sector. As a consumer of such analyses, I applaud your past contributions and strongly encourage you to continue or initiate new endeavors.

Need for a New Theory of Public Goods and Services

Ostrom and Ostrom have cogently summarized the methodological individualism in public choice theory and the underlying assumptions of individuals who are self-interested and rational, who have adopted maximizing strategies, and who possess information (p. 205). The same individuals are also an integral component of the theory of public goods and services (pp. 207–8).

The existing public goods and services theory emphasizes the exclusion principle which could be articulated as a concern for equal access. The theory in practice may not be current because much of today's public discussion is not with equal access but with claims for entitlements. Witness current discussions on the rights to a basic minimum income, rights to twelve to sixteen years of free education, claims to a minimum level of health care, and within a span of a few years three divergent claims on the education system (for excellence during the early space race, achievement of basic skills by the minority young, and now for liberation of human potential). The theory of public goods does not provide much assistance to the public decision maker in assessing or balancing the claims because the underlying assumptions are based on the "rational economic man." Claims for entitlement are balanced and allocated with political, not economic power. Perhaps it is time to search for modification of the existing theory or develop new theory which provides testable hypotheses. Daniel Bell is persuasive in his explanation of what is occurring in the real world but lacking in his search for an underlying theory (Bell 1974, pp. 29–68, 1975, p. 98). I would like to take liberty with Bell's explanation by summarizing it and embellishing it with a few thoughts of my own.

Bell states "the public household, as against the market which seeks to serve diverse private wants, has always existed to meet common needs, to provide goods and services which individuals cannot purchase

themselves—e.g., military defense, roads, railways, etc. In the last forty years, however, it has been transformed by its commitments to three new tasks" (1974, p. 32). He argues that the commitments were to establish normative economic policy in the 1930s, the underwriting of science and technology in the 1950s, and the establishment of normative social policy in the 1960s, ranging from civil rights to housing to environmental public policy to health care to income support. Government, he concludes, has made a commitment "to redress the impact of all economic and social inequalities" (1974, p. 33).

If Bell is correct, the traditional theory of public goods and services should be reevaluated. The re-evaluation should occur under conditions of increased expectations by self-maximizing individuals who in addition to seeking equal access are also seeking equal outcome. The public sector is now the focal point for debate and decisions regarding public goods and services as well as private wants as a result of a deliberate or accidental series of public policies which have increased expectations for social rights.

In the economic market, our claims are limited by monetary constraints but in the political market our claims are not subject to any constraints. A political constraint in the long run may in fact be pecuniary, the ability to publicly finance successful claims through the budgets of national, state and local, units of government.

There are a growing number of multidisciplinary intellectuals who are seeking to develop a quality of life index which would integrate diverse values and claims. I applaud the efforts but am reminded of Arrow's work on social welfare functions and the impossibility theorem. What may be needed is theory development on public goods and services focusing on equality or equal outcome. John Rawls recently completed a thought-provoking book, *A Theory of Justice*, which suggests a minimum equal outcome in the form of a "maximin criterion." He substitutes the criterion for the economist's utility theory. Rawls contends that we are risk minimizers and at the risk of having nothing will settle for a minimum outcome subject to minimal risk. Rawls does not address budgetary constraints or changing expectations but his work should receive more attention by those interested in public choice theory.

Need for Effective Institutions for Citizen Participation in Public Decision Making

Today there is much discussion and interest in and experimentation with grass roots citizen participation in public planning and decision making. Lappegaard has differentiated between two levels of citizen participation. The first is citizen participation to gain information, to have questions answered, or to derive the personal satisfaction of being a good citizen by interacting on an informal basis with public officials.

The second level of citizen participation is for purposes of influencing planning or decision making. The citizen participant is well informed, understands governmental structure, recognizes public officials with power, and is effective in being visible to public officials as well as to the media. There are times when it is difficult for the public official to determine which citizen represents a group, geographic area, or a transcending community interest. These problems can be overcome as we heuristically develop institutionalized approaches to citizen participation.

Lappegaard also raises a larger concern. His concern is with the impact that this level of citizen participation may have on the elective process. Most citizen participation at this level is with the nonelected public official. Institutionalized interaction between citizens and nonelected officials in the planning and decision-making process may erode the role and importance of the elected official. The elected official could be bypassed and elective representation replaced by participatory direction.

The literature has completed neither the necessary conceptualization nor theoretical underpinnings for this form of citizen participation. Again as a public sector consumer of public choice theory and methodology, I welcome your assistance.

Conclusion

There are additional public choice issues which deserve equal attention. Among them are intergovernmental relations, the institutionalization of anticipatory planning, a theoretical framework for growth and development, and alternative institutions for

linking planning and budgeting with decision making at all levels of government. I am confident that the agricultural economics profession, which has a long-standing tradition of applied public policy economics, will rise to the challenges and opportunities.

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An Economic Appraisal of Recent Commodity Market Performances

John A. Schnittker

Commodity markets in the United States and the world have performed poorly in recent years. I trust you will take my word that the evidence is in the data, and the data are all around you. A great deal has already been said or is being said about this, in present and past papers delivered to the American Agricultural Economics Association, and I see little reason to belabor the issue.

Markets have been giving agricultural producers erratic signals; they have been characterized by extreme uncertainty and instability whereas greater certainty and stability are still preferred by producers and consumers and would produce a better (more efficient) use of resources and a better (more equitable) distribution of production. So we need improved techniques for stabilization.

U.S. and world markets have been at the mercy of state-trading enterprises such as the USSR and China in recent years. Those nations move in and out of our markets more or less at will, often purchasing quantities so large as to severely and adversely affect economic sectors (U.S. food) and nations (India and Bangladesh), which cannot, in any sense, compete on even terms with economic and political giants such as the USSR and China. We need buffers against sporadic incursions into agricultural markets, especially in the United States.

Markets today lack enough information to function effectively in the new political and economic climate of 1972–75. Giant companies increasingly dominate the commodity and food sector, and two large but closed societies have become the principal market factors, either by their presence in or their absence from world grain markets. The world, however, knows little about what is happening in those societies or how unknown events there will affect agricultural markets. U.S. officials, companies, or persons with privileged information gained by virtue of function or position know far more than farmers or consumers do about what is happening and what imminent actions will affect markets. Both officials and large companies are also in a position to present, and often do present, the public with obsolete or intentionally misleading information about conditions inside closed societies or intentions to purchase which will affect markets. Government reports are inherently misleading in a fast moving situation. We need a policy of full and timely information to improve market performance.

There are many examples of severe adverse impacts of recent instability in U.S. agricultural markets. Cattle feeders were led into a trap in 1973 (and subsequently) both by market actions and by inept federal market regulation. Price controls on meats in 1973 encouraged withholding animals. Later, meat prices collapsed under the weight of accumulated supplies while grain prices soared. Price controls applied to meat at a time when price-stabilizing action should have been applied to grains and oilseeds in order to limit meat price increases played an important role, but I am not sure what role. Certainly the malfunctioning of markets cannot be given the entire blame for the roller coaster behavior of meat prices in recent years nor can inept regulation.

The sharp increase in meat prices in 1975, resulting from a corn crop failure in 1974 after reserves had been squandered in 1972 and 1973 is another example. The U.S. meat sector made the world's only major adjustment in

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feeding levels in 1974–75 because market prices performed a rationing function here, while other countries were able to buy nearly all the grain they could afford to buy from the United States to maintain comparative stability in their own regulated meat sectors.

The role of large state-trading nations in destabilizing our markets is too obvious for much more comment, as is the ability of such enterprises to enter our markets at bargain prices. The rest of the world is left to bear the costs of Soviet or Chinese purchases and European Community regulations, which prevent the extent of world grain scarcity from being communicated to European feeders even while U.S. feeders are being rationed severely. As Marshall Goldman said recently, in the context of the latest Soviet purchases, "some way must be found to transfer some of this cost to the Soviet Union" (p. 27).

Excess speculative activity fostered by extreme market uncertainty, by lack of information, by misleading and wrong information, and by lack of buffer or reserve stocks, has played an important role in poor market performance. I refer to the series of events that brought us $12 per bushel for soybeans, $1.00 per pound for pork bellies, and 66¢ per pound for sugar. Market analysts and regulators, especially the new Commodity Futures Trading Commission, have a fertile field here for study and action for many years.

Market action in recent years has squandered our grain reserves. Unregulated market action in the next few years may make it impossible to rebuild those reserves or may again deplete them before another crop failure occurs somewhere in the world. The United States, under the present Administration, will rebuild grain reserves only as an unwanted by-product of large crops; yet grain reserves, as much as a high and responsive agricultural production capacity, are a cornerstone of price stabilization policy both in the farm and nonfarm sectors. Further, grain reserves are a cornerstone of our agricultural trade policy and of our position as a secure world supplier of agricultural products. Grain reserves, not simply pipeline stocks, are in the national interest, Secretary Butz notwithstanding, and we should have them as soon as possible.

What is required to improve market performance is, first, to abandon both the dogma and the rhetoric of a free market agriculture. This is long overdue. Even those who preach it so fervently do not practice it, for events and circumstances will not permit them to do so. Unfortunately, holding out against needed and timely regulation of markets in the hope that the true religion of free and open export markets will yet be vindicated often postpones action until it is too late, as in the case of soybean export controls in 1973.

To cite another example, when Secretary Butz placed the U.S. Department of Agriculture in the way of unlimited grain exports via the "prior approval" system put in effect late in 1974, the scheme was officially hailed then as the way to avoid the hated system of "export licensing." It was that and it worked; it stopped the price spiral. Now, when the prior approval system may again be required in 1975 to insure that relatively stable food prices and the rebuilding of our own reserves have precedence over increased meat production in the USSR, it is opposed by its former sponsors in the Government because "it would represent export controls."

Agricultural production, exports, and prices are issues of high policy. It is worse than inept to argue that we must let, and that we are letting, our open agricultural markets function; it is false. There is a heavy overlay of policy involved not only in sales to USSR and China but in our agricultural trade relations with Europe and many other countries and in the question of reestablishing grain reserves. It would be well to recognize this.

In August 1975, it is almost certain that policy makers were debating the merits of very large additional grain and oilseed exports to the USSR at a cost of substantially higher food prices and an inevitable further destabilization of the U.S. food sector and for political benefits which may be large but less tangible. It was startling, in the context of events in U.S. and world agricultural markets, to hear a high U.S. official say in mid-1975 that the U.S. government has no targets with respect to our agricultural exports or agricultural prices and no danger points for prices or supplies beyond which regulatory actions would be taken. It was as if the U.S. government were only an interested bystander, rather than the principal participant, in these market events. This was either ordinary governmental fabrication or extreme naivete. I believe it is the former; the government is constantly managing agricultural markets and prices while telling us it is not.

The debate, if there is to be one, on improving the functioning of agricultural markets is

over the degree and the details of regulation, not over free versus regulated markets. The appropriate kind and degree of market regulation requires, first, an admission that new forms of regulation are not just temporary needs arising out of unusual events, but long-term requirements arising out of changed circumstances affecting agricultural markets.

We need to set upper limits on agricultural prices in the interest of general economic stability as well as lower limits in the interest of farmers. Feeding reserves into the market in times of reduced crops is the preferred form of regulation in this case, but when there are no reserves, policies limiting exports should be in effect. We need to raise agricultural price support levels very substantially for several years, both to encourage full production and to insure that some reserves are accumulated, as opposed to rapid expansion of grain feeding to animals and poultry at the expense of reserves. The possibilities for useful regulation of futures markets to foster market stabilization need to be exploited, as I believe they will be by the new Commodity Futures Trading Commission. We need an open information policy; full disclosure can often be a substitute for greater regulation.

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The Economics of Food Reserve Systems

Anthony S. Rojko

For many years the United States had farm programs that caused food and feed grain surpluses. The decade of the 1950s was a period of large grain stock buildup. In the early 1960s, these programs were changed to discourage further buildups and to facilitate drawdowns. After major exporting countries expanded output sharply in the late 1960s, however, stocks expanded again. Then production shortfalls in 1972 and again in 1974, particularly in the United States, depleted stocks to the lowest level in twenty-two years. Critically low stock levels, resultant high food prices, and uncertainty about food supplies have raised issues: should future programs have accumulation and maintenance of specific stock levels as explicit objectives and, if so, under what condition and by whom? Such issues have been treated in a number of studies (Bailey, Kutish, and Rojko; Steele; Gray; USDA 1974) and gave rise to the focus of this paper.

The first part of this paper defines a food reserve system, identifies the decision makers and the institutional setting in which decisions are made, and outlines the goals and the operational strategies available to achieve these goals. The second part presents the economic framework and alternative economic analyses and the implication of the analyses for food reserve systems.

Food Reserve System

The definition of a food reserve system used in this paper is limited to the food-feed-livestock sector and is concerned primarily with the *modus operandi* of commodity marketing. While emphasis is on grain, there is some allowance for the flexible feed relationship between grain and livestock. Stock levels, as determined by the short-term supply and demand situation and longer-term policies, are considered to be the key element of the systems discussed below.

The objective of this paper is to describe and evaluate alternative food reserve systems in the context of a number of different food policy goals. While some of these policy goals are identified, no attempt is made to arrange the order of priorities. Since the goals themselves may be contradictory, the relative weight given to each goal ultimately decides which food reserve system is preferable. For example, if price stability is paramount, a very rigid system might be chosen. If, on the other hand, price flexibility is desired so as to be a resource allocator, a system that permits price variability would be chosen.

This paper explores basic relationships that can provide a framework for evaluating alternative systems, given the goals; it does not advocate particular policy goals or particular food reserve systems.

A food reserve system, or more precisely a commodity marketing framework, is viable only if it meets the needs and furthers the goals of the major sectors of the economy. In a very broad sense, a food reserve system has to be tailored in some optimum fashion to apparent contradictory goals of the producers, processers, traders, speculators, consumers, and the general public. In real life, a precise definition of each sector's goals may not be possible nor is each sector necessarily neatly or homogenously defined. But the most obvious objectives of each may differ enough to warrant discussion if only to define areas of mutual interest or conflict. The goals which follow are discussed later: producing sector (strong prices and/or increasing net farm income, assurance against production and price shortfalls); processing sector (stable and/or increasing processing margins on a large volume, price stability and price certainty); trade sector (some price variability, stable and rising margins on a large volume); speculative sector (price instability, large volume); consuming sector (certainty of food supplies, low and stable retail prices); public sector (price

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certainty and adequate food supplies, including production, to meet food commitments at home and abroad, price variability).

At first glance, the listing suggests that despite the number of conflicting goals separating one sector from another, a price stability goal is common to most sectors and should consequently be high on the priority list. But closer inspection indicates that limited price variability may also be high on the list as a goal itself and may be an acceptable proxy in many cases for price stability. For example, any food reserve system that would prevent prices from running much below long-run equilibrium levels but would not interfere with price rises where supplies are tight would meet the pricing goals of the producing sector.

All of these sectors, particularly the trade sector, may be interested in enhancing their profit position by acting as speculators. Large profits and losses are only possible in a setting of price variability. The speculative sector can in turn perform a valuable function by pointing up resource reallocation needs.

Nature of Food Reserve Systems

Analysis of any food system must center on two key questions. Who are the decision makers? In what institutional setting are decisions made? Each different combination of a decision maker and an institutional setting defines a separate food reserve system. The number of possible combinations is large. However, this discussion is limited to identifying and evaluating only some systems.

In defining the decision makers there are four basic possibilities: (*a*) private firms (national, multinational, and quasi-public) make all the decisions; (*b*) a board or group composed of representatives of the public and private sectors makes all decisions; (*c*) government makes all the direct decisions; and (*d*) some combination of governments and private sectors shares the decision-making process.

The institutional setting in which decisions are made can take several forms. Food reserve systems can operate in unilateral, bilateral, or multilateral international settings. So far in the area of agricultural trade, the United States has tended to make more unilateral decisions, though many of these past decisions were made recognizing the likely decisions of the other countries involved, particularly major exporters. On the other hand, the International Grains Arrangement of a few years ago and the International Wheat Agreement are multilateral efforts. Food reserve systems can operate within the context of widely differing government programs. A specific government program which supports prices at certain levels is a setting quite different from one in which no direct government program exists. Food reserve systems can also operate in a context of comprehensively defined governmental rules and regulations or in a context of general regulations leaving considerable latitude for private firm decision making.

Traditionally, when it comes to operation of an economic system, the United States has avoided multinational approaches at least partially due to the belief that our competitive strength would insure better results than a negotiated arrangement. Traditionally, we have also tended to associate broad latitude on the part of private interests with the free enterprise system in a setting of government regulations. However, government regulation under the guise of protecting the free enterprise system can stifle the market and result in ineffective decision making. Ideally, it should be possible to combine the two—free enterprise and government regulations—in such a way as to achieve the objectives of both the market and public sector.

Operational Strategies

Several operational strategies are available for managing grain reserves: adjusting grain production (expanding or contracting), adjusting international grain trade by inducing or inhibiting exports (use of quotas, embargoes, calendars) and/or by inducing or inhibiting imports, maintaining contingency grain reserve stocks, and adjusting rate of feeding to livestock and international trade in livestock products.

In the area of production adjustment, short-term supply management is possible due to the substitutability between coarse grains and wheat for both feed and food use, and as farm outputs, and to the difference in hemispheric planting seasons. For example, in the United States, when the size of the corn crop is known in September, adjustments can be made in area planted to winter wheat and barley due for harvesting the following June—the ninth month of the feed grain marketing year. Adjusting acreage, however, is generally a

cumbersome way to stabilize supplies and market prices.

The case for export controls needs no further elaboration. Export embargoes are the extreme form of export quotas designed to completely cut off the flow of exports in periods of tight supply. Since an embargo is a drastic action with international repercussions, a formal embargo most preferably would be used only as a last resort.

Contingency stocks, for example, can be used with greater precision and timeliness to raise or lower market supplies and thereby stabilize prices. In the case of extreme fluctuations of crop output or export demand, a great advantage of a contingency reserve stock is its immediate availability as a solution to market shortages. A disadvantage is the cost of holding such stocks—cost of storage, and investment in inventory.

Little needs to be said about adjusting livestock feeding as a means of managing supplies. Feeding adjustments in the United States this past year served much the same purpose as actual stocks held in reserve in previous years.

The Economics

The major economic components of a food reserve system include production, consumption, trade, stock, price, and cost variables. All may be incorporated into a system of equations quantifying interrelationships. Quantifying the interrelationships that tie the food-feed-livestock sectors together is so complex as to make modeling difficult if not impossible. Labys has ably surveyed efforts in this area. However, two characteristics of the commodity markets should be reaffirmed. First, direct food demand for farm commodities tends to be price inelastic in general and particularly so the shorter the time period involved. Second, supplies available in any one crop year are relatively fixed. Thus, relatively small changes in supply in a relatively fixed period can result in large changes in price. Therefore, when market supplies continue at near normal levels from one year to the next, prices remain relatively stable even in the absence of government programs. However, cyclical overproduction and "random" production shortfalls have introduced periods of price instability.

Using conventional supply and demand interrelationships may be satisfactory in evaluating the impact on prices in normal or near normal situations, but not when supplies are tight. There is a key relationship applicable in both the normal and abnormal supply situations: the current price related to anticipated ending stocks of grain.

Comparison of previous stock levels with anticipated ending stocks indicates the anticipated change in the supply-demand balance, which is particularly critical in years of short supply. Thus, it is logical to expect the food-feed-livestock marketing system to find this single indicator—the expected carryout—used in conjunction with their expectations about the following year's crop to be essential in deciding to sell or to hold grain (farmer), to buy or obtain commitments for future use (processor and importer), and to buy, to sell, and how much to set aside for future sales (traders).

Figure 1 depicts the nature of the price-anticipated stock relationship under several different assumptions. In each of the cases, the expected price in the following year is assumed to be the same. Case A shows the expected demand for ending stocks in a food reserve system in which private firms make decisions under a system of minimum regulation and the country is basically a cereals economy. Without foreign trade the stock demand function could be expected to be steep. The amount of stocks held by private firms at any time would differ very little from the level of working stocks if the market price for current delivery was near the expected price for delivery the following season. Stocks would be carried over only if the market price for current delivery was sufficiently below expected price for the following year to at least cover cost of storage. The private incentive to carry over stocks is lacking unless market prices for current delivery are considerably below the prices anticipated for delivery the following year. Thus, considerable price fluctuations could be expected from production shortfalls unless the country's shortfall could be offset by imports from the world market.

Case B depicts a system in which the government underwrites a producer price level and maintains minimum price levels in periods of surplus supplies through direct purchases. As the market price approaches intervention or support price from above, the slope of the curve becomes flat. It will stay that way as stocks accumulate but then will begin to fall again as stocks reach large levels and become a price-depressing force on the market. If the

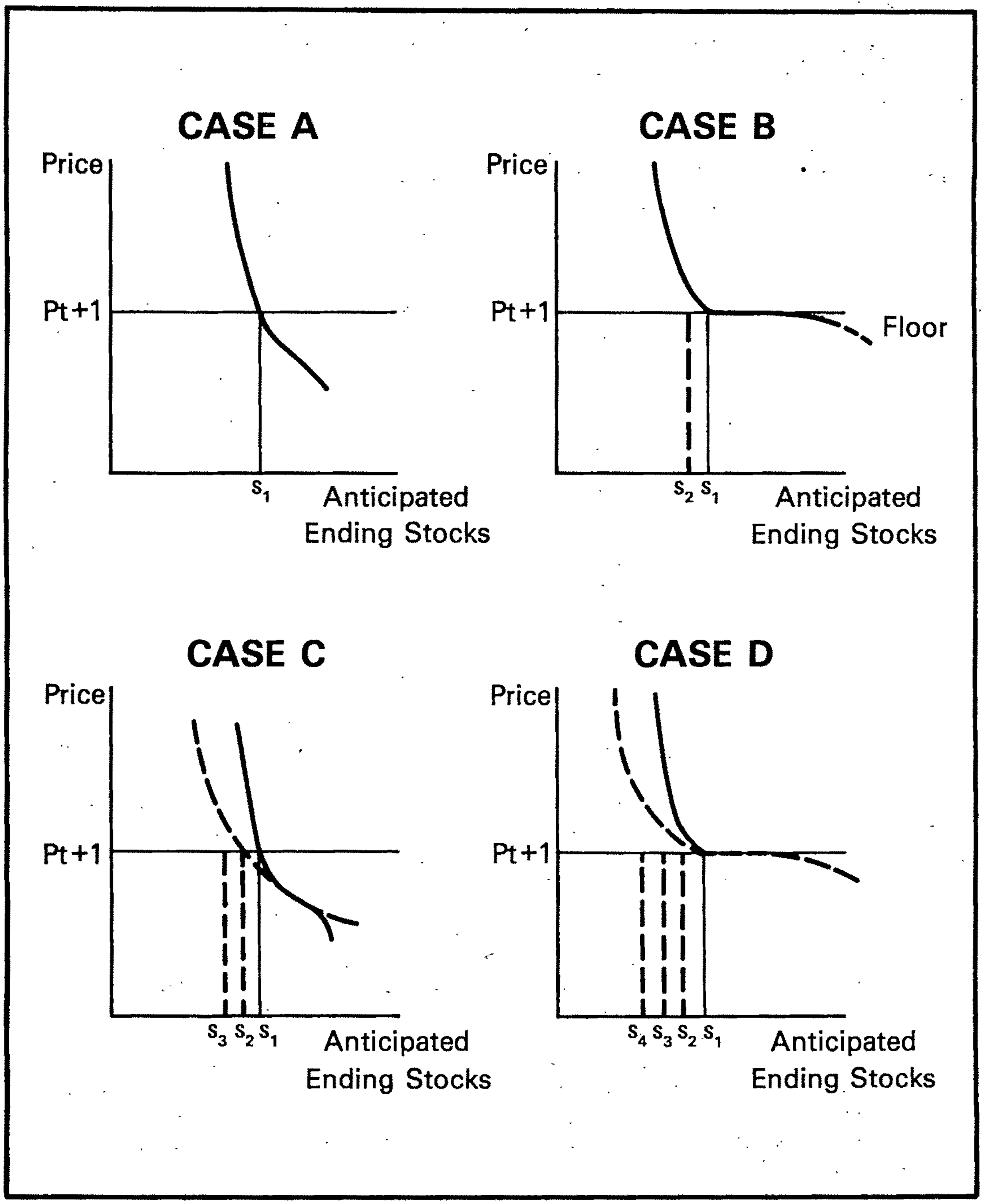

Figure 1. Hypothetical relation of price to anticipated ending stocks

intervention price remains above normal equilibrium price in a series of "good" years, an otherwise extremely expensive grain-marketing program can be bailed out only by periodic droughts or by some other unusual short supply circumstance. Of course, if a shortfall occurs before stocks can be accumulated as has been the case in the last two years, the slope becomes steep below some critical level of stocks. When government holds stocks, it is possible that this critical level is S_2 instead of S_1.

Now, suppose we superimpose a livestock economy. Case C shows the adjustment in the stock functions when all marketing decisions are made in a framework similar to Case A. If

the price of grain becomes too high, the amount fed to livestock will be reduced, releasing more grain for food use—the more price inelastic use. Thus, prices would not rise as much as they would have in the absence of the livestock economy. This is tantamount to a shift in the demand stock function to the left. It reduces the critical level of stocks to S_3 as food users feel confident that the livestock sector will adjust if necessary. This is what happened in the United States in the 1974 crop year when feed use dropped by about 33 million metric tons. When supplies become relatively large and feed becomes relatively cheap, livestock feeding will be encouraged and this tends to keep prices higher than would be expected under simple food demand situations. Case D is the counterpart for B and shows the shift effect of the livestock sector under government programs for grains.

Thus, countries that have only a minimum livestock industry are more dependent on imports to supplement their shortfalls unless they are willing to carry large contingency stocks. In contrast, countries with larger grain-fed livestock sectors would need smaller stocks to meet an equivalent shortfall so long as they were willing to adjust feeding. Because of the feeding adjustments following the 1974 grain shortfall, the rest of the world had more grain at lower prices than would have otherwise been possible. No single analytical system to my knowledge has been developed to weigh and evaluate the many different aspects of food reserve systems. Results from three types of analysis are presented here. The first supports the short-term price effects suggested by figure 1. The second looks at results from a long-run projections model. The third is concerned with results obtained from a simulation model designed to test different operational strategies for the U.S. wheat economy. Figure 2 shows the short-term price effects of different levels of ending stocks for U.S. wheat and corn. The relationships are based on multivariate graphic analysis. Thus, in the case of wheat, the price-stock relationship is net after taking into account effects of wheat feed, PL-480 shipments, U.S. commercial export demand, and population growth. For coarse grains, the effects of population, income levels, both domestic and abroad, are taken into account. In short, an attempt was made to abstract from usual supply and demand effects on prices (Houck, pp. 1121–22).

As expected, the price response is very low when stock levels are high. However, prices become very sensitive when anticipated ending stocks become low. In the case of wheat, for each change of supplies of 1 million metric tons, the price of wheat could change by $10 per ton. The corn price response of $4 per ton is weaker because adjustments in the livestock sector dampen demand.

The next analytical effort used the world grain-oilseeds-livestock model developed in the Foreign Demand and Competition Division (USDA 1975) to project long-run supply, demand, price, and trade for major regions of the world. The model was asked two questions. How high would the world price of wheat rise if some single world agency increased its contingency reserve level by 1 million metric tons? How much of this added contingency reserve would come from the United States? The answer is $0.66 (1975 dollars) per ton with 60% of the additional tonnage produced in the United States if all the major exporters shared the responsibility. If the United States held all the stocks unilaterally, the increase in world price levels would be the same. When the same questions were asked for coarse grains, the increase in world prices was about $0.30 per ton. Thus, in "good" weather years, it would cost the world user 30¢ per ton more for corn and 60¢ per ton more for wheat. Of course, the cost to the group carrying the contingency stocks would be the market price for stocks.

The Economic Research Service has some work underway studying the stock reserve issue. As part of this research project, Sharples and Walker at Purdue developed a Wheat Reserve Stocks Simulator Model, which evaluated use of different operational strategies for the period 1975–81 under induced random disturbances in production and exports. Their analysis relevant to this paper suggests that strategies which accumulate stocks reduce price variability but raise program costs. Their model is currently being expanded to feed grains.

Implications for Food Reserve Systems

The experience (observed and analytical) in the 1950s and 1960s suggests programs will be modified so that gradual adjustments do take place if supply and demand factors get out of long-range balance. It also indicates that even with sophisticated analyses the vagaries of

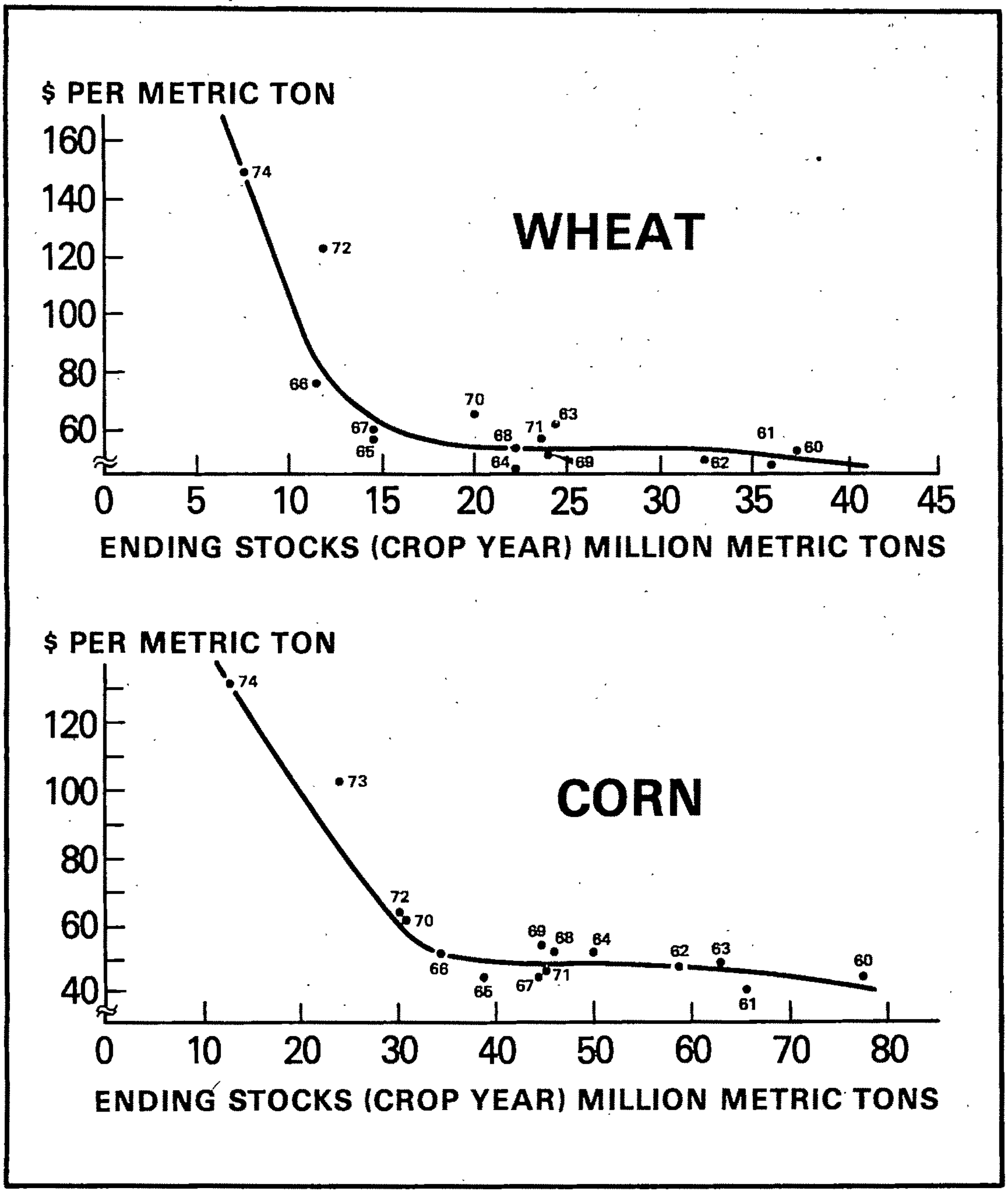

Figure 2. Price related to ending stocks (net effect after eliminating other factors, U.S. data)

weather and political decisions dispel the notion that fine tuning is possible.

The missing link in our analysis is recent experience in the kind of supply response we can expect following several years of a tight supply-demand balance and high prices. We have only the limited experience of the costly downward adjustments made following production expansion during World Wars I and II. But we have no experience for the modern commercial farm sector that is more specialized and highly capital-intensive. Some are well integrated between two or more stages.

Let us explore the economic implications that can be inferred in such a setting. The

knowledge of the frequency and extent of weather variability is a precondition for the choice of a food reserve system. Progress in this area has been slow. Any food reserve system must take into account import and export variability. The inclusion of the USSR, India, and China in a world commodity marketing system increases the frequency and the range of variability in world import demand and prices. A food reserve marketing system where stocks reach critically low levels is costly to final consumers. Crop shortfalls not compensated for by adequate reserves could be profitable to crop producers if protected from low price levels, but grain traders might profit the most from such developments. The benefits versus costs accruing to the livestock sector under volatile prices need to be studied. Windfall profits can be made but serious losses can also be experienced, as happened to cattle feeders in general this past year. What the few largest countries or economic units do has very serious implications for the world particularly if each intends to use world commodity markets to solve internal policy problems. Thus, a food reserve system might consider special treatment for these countries.

Furthermore, if two or three major countries that have considerable impact on world commodity markets do not assume the responsibility for stable world prices, the remaining smaller producing and consuming countries may in self-defense seek to form their own coalitions. Frequent declines of world stock levels to critical levels increase the profitability of speculative market manipulation. This could involve participation of multinational firms or even foreign governments. Moreover, what is not widely appreciated is that it invites large scale defaults when prices decline. Preventing these from happening might be very difficult. The analysis indicates that private firms would find it unprofitable to carry large enough stocks for price stabilization within needed bounds unless there was government subsidy. Single firms should not be expected to carry the cost without compensation. The overriding conclusion from the econometric part of the analysis seems to favor a food reserve system that would keep commodity reserves somewhere between low critical levels and price-depressing high levels. Analysis presented here suggests that maximizing the welfare effects of food reserve system depends on an eclectic approach mixing private enterprise and government regulations. The real question is the efficiency, the information aspects, and, more importantly, the responsiveness of the system to the needs of all the sectors.

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The Problems and Challenges for International Commodity Models and Model Builders

Walter C. Labys

Researchers today are encountering overwhelming economic and methodological problems in specifying, estimating, and simulating commodity models in an attempt to adapt them to our rapidly changing economic environment. These problems in fact become amplified when dealing with international commodity markets where the uncertainties of political and economic behavior increase as do the variety of shocks to the system. Since our means of coping with these problems are limited, a substantial gap exists between the simplistic nature of our models and the complexities of international markets. This paper first provides a background on methodology and problems; it then offers suggestions as to how model builders can cope accordingly.

Background

A commodity model is defined as a quantitative representation of a commodity market or industry; the empirical relationships reflect demand and supply aspects of price determination as well as other related economic, political, and social phenomena. The methodological approaches taken to construct such models can differ considerably. Among the major methodologies described in Labys (1973, 1975b), econometric market models, spatial equilibrium models, and system simulation models are applied most often to international commodity markets.

Common to these methodologies is a structure represented as follows:

(1) $D = d(D_{-1}, P, P^c, A)$,

(2) $Q = q(Q_{-1}, P_{-\theta}, N, Z)$,

(3) $P = p(P_{-1}, I/D)$,

and

(4) $I = I_{-1} + Q - D$.

World demand D is explained as being dependent on prices P, prices of one or more substitute commodities P^c, and economic activity A. World supply Q also would depend on prices as well as natural factors N (such as rainfall) and a possible policy variable Z. A lagged price variable is included since the supply process is normally described using some form of the general class of distributed lag functions. These prices are also linked to the inventory/consumption ratio I/D in the price equation. The model is closed using the world market clearing identity which equates inventories I with lagged inventories plus supply minus demand. Other possible explanatory factors, expectations variables, and the customary stochastic disturbance term are omitted for simplicity.

When the above model refers to national commodity behavior alone, the inclusion of trade relationships would give it an international character. For example, if commodity exports X are determined endogenously and imports are given, equation (4) would be replaced by two equations:

(5) $X = x(X_{-1}, P, A^x)$

and

(6) $I = I_{-1} + Q + M - D - X$.

Many of the problems encountered recently in applying and adapting these models pertain to international as well as domestic commodity markets, but our focus is on the former. Forecasting of commodity quantities and prices since 1972 has been a major problem for international models. Not only did forecast and actual values differ considerably but forecasts in nominal rather than real terms proved impossible because of rapidly increasing inflation, the rates of which varied considerably among nations. Relevant to this problem is that the market structures underlying international models change more rapidly than do the structures inherent to domestic or

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macromodels. The impact of this structural instability is the ready obsolesence of model parameters.

International models also have suffered from specification error, particularly in the omission of monetary and speculative factors which increase in importance during periods of uncertainty. Fluctuations in exchange rates made price and income forecasts difficult, most models excluding these factors. Speculation principally in the form of futures trading also influenced prices. And models embodying free trade were hampered because of actual or expected movements towards producer cartels.

Finally, the widening of price differentials between commodities led to substitution patterns which most models could not duplicate, either because of improper specification or of a failure to link the model in a multicommodity framework. Inherent to these problems was a shift in the technological-ecological availability of commodities. Factors such as these as well as climatic conditions also caused commodity inventories to deviate from normal patterns.

In discussing contributions which can help in solving some of these problems, a general review of commodity modeling developments is avoided. This has been provided recently by King and by Labys (1975a). Instead, emphasis is placed upon a set of particular challenges which we could hope to meet.

Improving Model Forecasts

In general not much progress has been made in improving forecasts based on international commodity models. Most attempts to look directly at forecast performance have employed time series or "unobserved component" methodology. For example, Labys and Granger applied spectral analysis to decipher commodity price movements and subsequently to fit various time-series models. The forecast performance of these models, particularly of the simpler no-change or naive expectations methods, was found to be superior to that of econometric equation methods. Recently these results have been confirmed by Teigen, who compared price forecasts based on five models of the U.S. beef and cattle markets with those of time-series methods. Along the same lines, Cromarty and Myers advocate the integrating of time-series methods with econometric methods, including the careful use of judgmental observation. Of course, one should remember that commodity models are superior for explaining behavioral aspects of markets, especially during periods of uncertainty. To use these models to advantage, what we need is a thorough study of the characteristics of commodity models which contribute to their forecasting efficiency over time.

Updating Model Parameters

A problem often responsible for poor forecasting performance in international models is that structural adjustments in the underlying markets result in changes in the level of model parameters (as distinct from changes in model specification). These changes can arise from adjustments in the response of economic decision units such as shifts in technology or in tastes and preferences. Similarly, they can stem from the approximations used for macrorelations. Here changes in the relative importance of groups constituting the microunits of such a relation can upset the given weighting pattern and hence the assigned parameters.

One approach taken to counteracting these difficulties has been to assume that the estimation process will improve as more information is added. As an application of time-varying parameter methods, Freebairn would combine Bayesian estimation strategies with adaptive control theory. The updating relations used in his model of the U.S. beef market would thus be defined as recursive functions. Based on an equation containing a single dependent variable y and independent variable z,

$$y_t + B_t z_t = u_t, \tag{7}$$

the parameter adjustment function would be of the form

$$B_{t+1} = H_t B_t + w_t, \tag{8}$$

where H is a coefficient transition matrix and w is a stochastic vector. Integrating these factors into the model according to adaptive control theory, Freebairn analyzes the selection of optimal beef import quotas. While some of these outcomes are reported in terms of control policies by Rausser and Freebairn, it would be useful to learn how the updating

procedure could be used to improve basic model forecasts since 1972.

Other approaches to the time-varying parameter problem include systematic (nonrandom) variation methods and random-coefficient methods. Of the former, the work of Cooley and DeCanio based on the theory of continuous parameter adjustment has immediate implications for commodity forecasting. They found systematic variations in parameters which could be explained in dealing with supply functions for cotton and wheat. In addition, the method provided a means to test the formulation of expectations by farmers which would be valuable for making annual forecasts. With respect to the second or random-coefficient method, Ong has found it useful in improving forecasts for daily prices and quantities in the U.S. hog market.

Including Monetary Factors

Another problem of international models relating to specification has been their frequent omission of monetary factors, namely inflation and exchange rates. The accepted procedure for incorporating the influence of inflation in a commodity model has been to deflate commodity prices by an index reflecting movements in the general price level, P/P^i. Such an index as represented by the gross national product deflator or the wholesale price index should be well constructed and predictable.

Lovasy, however, has argued that the price index should be included directly into a given commodity price relationship, for example as

$$P = p(P^i, I/D). \tag{9}$$

This implies that commodity prices do not vary in a one to one fashion with the general price level but only in proportion. Yet a full determination of the influence of the general price level would require examining inflationary factors that shift demand as well as supply. On the demand side, inflation can force portfolio managers to switch from monetary to physical or more tangible assets such as commodities and changes in income distribution can lead to a shift in patterns of commodity consumption. Nonetheless, these phenomena cannot be easily modeled, nor can the impact of inflation on supply be easily specified.

A greater possibility exists for including the impact of exchange rate changes, since the latter can be introduced directly in demand, supply, or trade equations (leaving aside commodity feedback effects on the economy). These equations typically feature national price series and hence national currencies. Equilibrium model solutions are obtained by converting the price series to a common currency prior to estimation. In doing this, Bjarnason, McGarry, and Schmitz argued that one should use a base year exchange rate (and base year deflator if necessary), because yearly rates do not satisfy the "purchasing power parity theory," i.e., that exchange rates vary directly with the purchasing power of a nation.

Elliott, however, prefers estimating the equations in national currencies and then converting the equations to a common currency by multiplying the price parameter by the assumed exchange rate. For example, the demand equation for country i would include the exchange rate e_{ij} relative to country j:

$$D_i = b_{i0} - e_{ij}b_{i1}P_i + b_{i2}A_i + u_i, \tag{10}$$

where e_{ij} is variable. Inflation could also be included by deflating the national price series stated in national currency prior to estimation. In a related empirical study dealing with cocoa, Lamond has assessed the impact of exchange rate adjustments on cocoa imports and consumption. Dominguez also has constructed a general arbitrage incentive model for cocoa which measures the interspatial price relationships between London and New York as a consequence of the 1967 pound devaluation.

Integrating Speculative Phenomena

Speculative and futures market activity which normally increase during periods of economic uncertainty also constitute an important commodity influence. This has been noted recently by Labys and Thomas who report the existence of a close relationship between price movements and futures speculation since 1972, based on a study of nine commodities traded on futures markets in London and New York.

The possibility for modeling interactions between futures markets and physical markets stems from two prevalent notions: that futures markets accommodate the intertemporal allocation of commodities, and that they also provide a forward pricing function. Both of these are consistent with the supply of storage

theory, whereby futures prices PF can be substituted for expected prices P^e in

$$(11) \quad PF - P = P^e_{+1} - P = f(I/D)$$

with inventory coverage providing a link between the two. Certainly such a relationship would be vital for explaining the role of inventory phenomena regarding recent speculation, such as that found in the grain markets. With respect to empirical studies confirming this interaction, Kofi has shown that the forward pricing function is more evident for markets with inventories of an annually continuous rather than a discontinuous nature, e.g., wheat versus potatoes. And Peck has shown that the pricing function improves as producer utilization of a futures market increases.

Based on work by the latter as well as by Labys and Granger, the commodity model, equations (1)–(4), can be expanded to include futures market activity. The price equation would now contain the futures price PF of contracts for delivery in k:

$$(12) \quad P = p(PF_k, I/D).$$

The futures price would preferably be endogenous, being determined by adjustments in the corresponding futures market. Such adjustments center upon speculative and hedging activity, for example, as can be measured by net long speculative commitments S^n and net short hedging commitments H^n for contracts also for delivery in k:

$$(13) \quad S_k^n = s(PF_k, R),$$

and

$$(14) \quad H_k^n = h(P, PF_k - P, I),$$

where R is an appropriate interest rate. We still await evidence regarding the performance of such a model. For those international futures markets where data describing speculative and hedging commitments are not reported, Wymer has devised an alternative approach based on his continuous disequilibrium model of the world sugar market.

Linking Models

What the previous two sections reveal is the need to relate commodity models to the broader economic environment. During the recent period, errors in macroforecasting as well as commodity or microforecasting occurred because of a failure to relate the two. Research in linking macro- and micromodels which has taken place suggests that there is more than one philosophy to be followed. As an example, a class of "commodity oriented development models" proposed by Labys and Weaver would interrelate a macroeconometric planning model for a developing country with several commodity models. For a country which is a major producer of one or several commodities, the impact of changes in related domestic investment strategies can be evaluated by linking the export sector of the macromodel to commodity models which generate prices based on world market conditions.

More germane to the present discussion is the linkage of a number of regional or macromodels with a number of commodity models in an international context. As envisioned for the LINK model, Adams would relate commodity demand with economic activity in the developed countries; commodity models would yield prices determining export and import prices, and the resulting commodity export pattern would give foreign exchange earnings for the developing countries. An iterative procedure would assure consistency between the macromodel variables such as income and the commodity quantities and prices. Since this project would require a substantial number of commodity models, Behrman and others have begun to construct minimum standard commodity models, that is, "mini models" designed to emulate market activity by including only the major international commodity characteristics.

Such models also have provided the basis for work by Hicks at the International Bank for Reconstruction and Development pertaining to the SIMLINK model system. Some twenty commodity models have been integrated within a macroeconometric regional income determination framework. Import demand for the commodities stemming from economic activity in the developed regions is compared with commodity exports from the developing regions, price levels being a function of the imbalances between the two. Not only can commodity prices be forecast in this broader context but multicommodity substitution patterns can be explored.

One further development stemming from work by Hudson and Jorgenson would integrate the determinants of demand and supply

embodied in a conventional macroeconomic model with the determinants of industry or commodity demand and supply reflected in input-output analysis. While their study refers to the role played by the demand and supply of energy commodities (crude petroleum and natural gas, refined petroleum, electricity, and gas) in long term U.S. growth, it does include determination of energy imports and exports. King would also find such an approach useful for dealing with agricultural commodities. He suggests a framework in which demand for these commodities is based on a linear expenditure system; the agricultural sector is modeled using input-output analysis, and commodity models explain supply. Some of these features have recently been embodied in the Nigerian agricultural sector model constructed by Byerlee and Halter.

Examining Political Influences

A final yet obvious aspect of international commodity forecasting is the extent to which commodity behavior is dependent upon political decisions. Commodity markets involving some degree of government intervention normally are modeled by including some policy variables or policy instruments through which policy is implemented. Such variables normally are specified as exogenous. Although government intervention can relate to decisions taken concerning monetary factors, decisions analyzed in international models typically relate to trade and production policies. These can include fixed import duty, ad valorem import duty, variable import levy, fixed export subsidy, fixed import quota, percentage import quota, bilateral quantity agreement, and domestic price support or acreage allotment. An example of the impact of trade policies on long term forecasts can be found in the spatial equilibrium trade model of Schmitz and Bawden related to the world wheat market. No results have appeared concerning how the model's forecasts have held up over the recent period. With respect to support price and acreage restriction policies, Houck, Ryan, and Subotnik have shown how to combine these policies into an "effective support price" variable. Impacts of these policies as related to soybean support prices as well as to crops competing with soybeans are evaluated in the soybean model constructed for this purpose.

A more recent approach would consider government intervention which has continued for a sufficiently long time that it exhibits certain regularities. This behavior can be described analytically and integrated into a commodity model, the government or policy variables becoming endogenous. Among the theories available for explaining this behavior, the political regularities can be regarded as manifestations of optimizing behavior on the part of policymakers. This theory has been contained in simulation studies which attempt to maximize some social welfare function. However, an approach advocated by Zusman as being more realistic would view "political behaviour as a process of accommodation among conflicting interests, where the attained political-economic equilibrium represents a simultaneous solution to the economic system and the associated political conflict" (p. 2). To illustrate this view, he presents a sugar model embodying the political relationships according to the theory of cooperative games, with implications given for Israel's sugar import policy. No forecasting results of applying this method have appeared.

Conclusions

This paper has focused upon a number of econometric approaches which can be taken in constructing and applying international commodity models during a period of major economic change. We have thus examined the assumptions underlying the models as well as the responses that model builders can make. But the underlying premise has been that such models will remain useful for explanatory and forecasting purposes. Given present limits, this paper could not deal with a number of other important factors. For example, it would be useful to study the integration of public forecasts, the use of communications technology for more rapid updating, the benefits of modeling climatic conditions, the specification of noncompetitive market adjustments, the introduction of better measures of risk and uncertainty, the analysis of intercommodity substitution, and improvements in modeling inventory-price dynamics. But the approaches discussed should offer immediate possibilities for model revision.

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The Relevance of Agricultural Economics to Industry
(Bernard L. Sanders, Farmland Industries, Chairman)

The Role of the Agricultural Economist in Industry

C. E. Erickson

Agricultural economists are employed by agribusiness firms that vary widely in size, structure, and enterprise. Thus, I undertook a survey of agribusiness firms to better describe the role of agricultural economists in industry. The response to the survey was outstanding by statistical standards: 84.4%. Although it may not have been entirely representative, I consider the sample to be a good cross section of agribusiness firms and to effectively portray the broad range of activities in which agricultural economists in industry are involved.

Perhaps the questionnaire limited respondents to answers that mirrored my own views; however, I was very much impressed with the coincidence of agreement with the "biases" I have held for so long. It is encouraging that others concur that some changes are needed in the training of agricultural economists and that those of us who are industry professionals need to make known the deficiencies and be willing to work toward their elimination.

This and the next few paragraphs summarize the responses of twenty-five firms. The principal activities of professional agricultural economists in industry are forecasting and general economic analysis. Although not specifically defined by each firm, the latter may be described as including a wide range of subject areas involving consulting, impact analysis, policy studies, etc. Long-range planning and operations research were less frequently identified as functions performed.

The M.S. degree predominates among firms surveyed, with B.S.'s and Ph.D.'s about equally represented. Based on recent hires among the firms surveyed, however, a trend toward Ph.D.'s seems to be developing. Perhaps reflecting the preponderance of M.S. degrees, most firms utilize a more descriptive, subjective type of analytical approach, as opposed to quantitative, model-oriented analysis.

Based on the responses of the firms reporting, extension economists are not a heavily used resource. Most indicated contact as being "occasional" or "infrequent."

Analytical results are presented orally and in memo form, as well as in more formal reports. Where the reporting method was ranked, oral presentation was indicated as primary. Considering the close relationship between most agricultural economists in industry and operating personnel, it is not surprising that communication was an area identified as needing more emphasis in academic training.

Of the twenty-five firms responding to the survey, Purdue, with fourteen mentions, was most often identified as doing the best overall job of preparing graduates for careers as agricultural economists in industry. Oklahoma State was a distant second with four.

These are the "facts," and occasionally, there is more. I'd like to explore some possible additional observations that might be made, based on my knowledge of the firms, the people responding, and many members of their staffs. If this survey had been conducted ten years ago, many firms would not have had even one agricultural economist functioning as a professional analyst. In other words, the agricultural economist in industry has "come into his own" and gives every indication of remaining a key contributor to corporate activities.

It can be argued that this phenomenon is the result of a combination of many forces, not the least of which is corporate affluence, making it possible to afford a resident "seer." To the extent that many earlier agricultural economics majors gravitated to operational

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positions, the way may have been paved for the entrance of others in staff positions. The general expansion of college and university training following World War II can be credited with spawning a variety of management training programs which, in turn, called attention to the need for more than just "line" personnel. Obviously, there are many other reasons for the increasing numbers employed by industry, but it appears that the agricultural economist has become, and should continue to be, a prominent feature in decision making in agribusiness firms in the United States and will likely be found in increasing numbers in firms abroad.

There are no corporate structures that seem to have a "corner" on agricultural economists, as private or publicly held firms and cooperatives all utilize their services, nor is there any discernible difference in the utilization of agricultural economists by kind of firm. The extent to which commitment is made, however, is observed to be directly related to the training of the top management. For example, if an analyst has moved up through the ranks to an operational position, there is a tendency toward larger, more sophisticated departments providing analytical service.

Based largely on personal knowledge, but supported by the survey, I believe those holding only a B.S. degree will soon become a definite minority. In fact, it is not unreasonable to predict that with few exceptions, new entrants will have at least an M.S. and many more will hold a Ph.D. B.S. programs in general fail to provide the specialization in courses necessary to permit identification with analysis as a vocation. Those with only a B.S. who become involved in this area will probably gravitate to the position from some other starting point.

The use of extension personnel as sources of information or counsel varied largely with the orientation of the person heading the analytical department. If, for example, the director of economic analysis was a former extension economist, frequent contact was noted. Likewise, if the firm was a cooperative, more frequent extension use was noted. Privately held firms used extension personnel least often.

Although the complaint was not universal and not necessarily unique to large or small firms, communications was mentioned as a deficiency by nearly half the respondents and qualifies as worthy of comment. Writing skills are generally not required beyond freshman rhetoric courses. Some agribusiness curricula include speech, business letter, and report writing courses, but most agricultural economics majors have a tendency to look upon such courses as "nonessential." Experience confirms that communications courses cannot afford to be left in the elective category and should not be limited to a three-credit-hour contribution. This same criticism could likely be leveled at any field of specialization but without the ability to communicate, a large percentage of technical talent goes unused.

One of my colleagues described the communication problem as one of "clarity of thought." The fault may be not that undergraduates are ill prepared, but that during the graduate program, so much emphasis is placed on highly detailed theory and research that communicating skills may atrophy through disuse. If this is correct, a refresher within the graduate program may be in order.

By contrast, most respondents reported that graduates were receiving enough theory and considered their mathematical training to be adequate to good. There were, however, a sufficient number of responses indicating deficiencies in quantitative expression to justify a brief comment. Math, through calculus, and a couple of statistics courses are probably sufficient to handle requirements of most firms. Anyone needing more is likely being utilized as a technician rather than as an economist. On balance, most schools seem to be doing satisfactorily in preparing students for business requirements in noncommunication skills.

There seems to be no particular correlation between the size of firm and the number of professionals employed. One firm with less than 6,000 total employment had twelve agricultural economists engaged in economic analysis, whereas another firm with more than 40,000 employment had only two.

The growing shift from the B.S. to advanced degrees for new hires for analytical positions reflects a greater awareness of the value of both maturity and additional training. Successful completion of at least an M.S. degree identifies the candidate as one who is capable of independent research as well as one who is more likely to find challenge and satisfaction in research. This is not to say that those with only a B.S. cannot find happiness and be successful as researchers, but other things being

equal, the odds favor the holder of the advanced degree.

As a consequence, institutions and departments should review their programs to ensure that options are available which more nearly prepare a graduate for an industry position. Differences of opinion exist as to the purpose of education and, in particular, advanced study. It is not suggested that universities become "vocational schools" for industry, but, as an increasing percentage of graduates find their future in industry, the question of "how well are they prepared?" should at least be asked.

In the opinion of more than 50% of the respondents, one university was doing a better job than most. Even discounting the possible "alumni" bias, 40% of the respondents identified Purdue as one of the two schools doing the best job of preparing agricultural economics graduates for careers in agribusiness. It may be advisable to look at their program.

Claud Scroggs is presenting a paper that treats, in depth, the relationship between industry and extension agricultural economists. I do not wish to intrude on his subject area nor to take a position based on limited research, but I would like to offer a couple of personal observations. Some extension economists enjoy a wide industry acceptance, while others do not. Those that do tend to "tell it like it is," whereas those that don't generally serve up "warmed over" U.S. Department of Agriculture statistics and rationalizations.

Those same individuals that are most often part of industry programs are also heavily booked for producer meetings. I consider this something more than coincidence. I believe the producer, like we in industry, wants something more than the last *Feed Situation* rehashed. So there is no misunderstanding, this is not a criticism of the Economic Research Service or the *Outlook* and *Situation* staff—we respect them and read their material from cover to cover—but when it has been thoroughly digested, it is not uncommon to hunger for a different course, if not a new chef.

This leads me to the observation that extension economists are not "in the hip pocket" of industry, as implied by Hightower in *Hard Tomatoes, Hard Times,* or, if they are, no more so than they are in alliance with the producer whom they also serve. Because he has recently retired after thirty years on the extension staff at the University of Illinois, I consider it appropriate to identify L. J. "Larry" Simerl as one of those who served his constituency capably, conscientiously, selflessly, and always left his readers and his audience feeling just a little bit smarter when they finished reading his letter or listening to one of his speeches.

When I was on the Industry Committee of the American Agricultural Economics Association, we attempted to develop a program of professional exchange between industry and academia. Although no formal procedure was or has been established, I am personally very enthusiastic about the concept. An increasing number of firms are taking advantage of the opportunity to utilize sabbatical talent. This sort of program represents a mechanism of directly communicating the role of the industry agricultural economist, as well as assisting in curricular overhaul.

A final observation: both schools identified as doing the best job of preparing graduates for industry careers have staff members who have been in industry positions or have spent sabbaticals with industry. Perhaps it's just coincidence, but I think not.

It is clear that industry has a need for agricultural economics majors and, based on personal knowledge, that need is growing. This suggests that institutions training students for careers in industry need to become attuned to the particular demands placed on the industry economist. I have no illusions about revamping graduate programs as a result of this presentation, nor do I presume that my views are necessarily shared by all of my industry counterparts. But, considering the near-unanimous identification of forecasting as a primary activity, a personal observation may be in order. Forecasting in agribusiness firms encompasses a broad range of subject areas and involves both simple and complex techniques. Some firms lack facilities to utilize a strict econometric approach, so less sophisticated tools should be made available. Methods taught thirty years ago are applicable today, yet many graduates are lost unless they have a computer terminal at their disposal.

To summarize, agribusiness firms are employing increasing numbers of agricultural economics majors for professional analytical positions. Although the majority currently employed hold only an M.S. degree, Ph.D.'s are becoming more numerous. The emphasis placed on forecasting suggests the need for

some specific training in addition to fundamental backgrounding in sector interrelationships. Give students a problem—make it real—something they can relate to—they'll be forever in your debt!

The business world is not static. No matter how sophisticated the model, there are unexpected, exogenous shocks lurking around every corner. Impress this upon the student and he'll be less likely to be disappointed with an industry career. Equip him with both "hand tools" and "power equipment."

Insist on maintaining high communication standards. It isn't enough that the graduate know what he's doing; can he show or tell others? I am told that many Ph.D. committees are surprised by the relative difficulty that some candidates have in expressing research objectives, methods, and results. Perhaps the program needs a better balance.

Industry is certainly not blameless in this problem of preparing students for careers in industry. It has been easy to criticize but far more difficult to become involved in corrective action. There is a wide range of opportunity for those of us in industry to take part in this process, including professional exchange, internships, *active* institutional membership in the AAEA, a willingness to acknowledge academic viewpoints as well as our own, and perhaps most importantly, a willingness to open up and maintain clear channels of communication.

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The Relevance of University Research and Extension Activities in Agricultural Economics to Agribusiness Firms

Claud L. Scroggs

Concern about the relevance of work carried on by agricultural economists probably began three-quarters of a century ago with the appointment of Henry C. Taylor as the first professor of agricultural economics in a land grant institution. The dialogue has continued with changing emphasis during periods of depression, war years, overproduction, and structural changes in the production sector resulting from the historic migration of farm workers to urban centers and out of agricultural employment. Castle in 1970 warned that flexibility in organizational structure of research and extension activities would be necessary if programs were to have great relevance to fast changing and nonstatic problems. Johnson's scholarly address to the American Agricultural Economics Association in 1971 argued that agricultural economics is not dead or dying just because problems of the 1970s are different from those of a decade ago. Grove, Crockett, and Narrie elicited spirited viewpoints in their comments and replies regarding "irrelevance" as viewed by professional agricultural economists. With regard to work relevant to the economic problems of commercial agriculture, Castle correctly stated that studies on the farm firm and nonfarm firm, performance of the industry, and commercial agricultural policy are areas of study experiencing the greatest decline as public concern and intellectual excitement are being generated elsewhere (p. 832).

To explore further the opinion of Castle and to provide myself with an updated view of relevance of university research and extension activities in agricultural economics to agribusiness firms, I surveyed the chairman of each department of agricultural economics at land grant universities in our nation. In addition, either by letter or by telephone, I requested viewpoints and opinions from administrators of land grant institutions, as well as a large number of economists employed by agribusiness firms, trade associations that are agricultural in nature, and farm organizations. Responses received were most helpful in broadening my understanding and knowledge of present programs and activities. In some instances, the information was sketchy and far from complete. From others, great pains were made to give detailed facts on all research and extension activities as well as on the interrelationships of the teaching function with the other two. Interpretations and conclusions reached from study of this mass of information are totally my responsibility and an honest effort to bring into focus relevance to agribusiness firms as I see it. In performing this chore, I do so as one who at one time wore the research and teaching hat at a land grant university. Moreover, my longer tenure has been as director of economic research for a major regional farmer cooperative.

This paper has five major purposes: to examine the direct and indirect benefits to agribusiness firms from better informed agricultural producers, to present views on types of university research and extension activities that should be emphasized, to discuss possible conflicts that exist between university activities and the programs of agribusiness firms, to explore the potentials and problems of joint university-firm research activities, and to bring into focus the viewpoint of agribusiness firms regarding the relevance of university research and extension programs.

Benefits from Better-Informed Producers

University research and extension activities that improve the knowledge of agricultural producers do benefit agribusiness firms directly and indirectly. If all agricultural producers were as well informed on technical,

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economic, and business aspects of agriculture as the top 5%, most agribusiness firms could operate much more efficiently in both purchasing and marketing activities. Better informed producers could tell suppliers what production inputs they need instead of requiring suppliers' assistance in selecting alternative herbicides, insecticides, and the like. Well-informed farmers do a better job at enterprise selection for each year and at utilizing the futures market to hedge returns from marketing their products. Knowledgeable producers can produce a product better suited to market needs—better in terms of variety, grade, staple length, moisture content, and the like—and thus enhance prices received and enable marketing firms to develop more sophisticated marketing programs.

Because of the lapsed time between production cost outlays and eventual payment to farmers for marketings, capital requirements for agricultural production have been escalating at unprecedented rates. This fact alone makes it essential for producers to be well informed about general business practices. In terms of accounts receivable, it would certainly aid business firms if all producers were better informed about, and able to understand, credit practices and operating policies of business firms, a definite weakness in today's scenario of producer-firm relationships.

Many firms involved in selling production supplies to producers must bear the cost of educating producers whose knowledge level is below that required to understand the technological and/or scientific facts relevant to the use of some products and services. To the extent that farmers are better informed, whether through extension or other educational efforts, costs borne by agribusiness firms can be reduced. In a cooperative, better-informed producers can provide better board members and theoretically should improve the management of local, regional, and interregional associations. On the other side of the coin, the poorly managed agribusiness firms should expect nothing but bad relations with better-informed producers.

Needed Research and Extension Emphasis

Representatives of universities who responded to my inquiry were poles apart regarding types of university research and extension that should be emphasized. Many thought that basic research would be most beneficial to agribusiness firms, as well as to producers and ultimately to consumers. This same group believed that short-run benefits are derived from applied research but that only basic research could produce long-run benefits to all segments of the industry. Others felt just as strongly that all research and extension activities should be directed toward applied research and problem solving. While some claimed their programs attempted to emphasize the "total systems" nature of the food industry or a balanced program serving all segments, others recognized that many agricultural economists at land grant universities have never really brought new realities of the agricultural structure into sharp focus in evaluating research and extension programs. For several departments, especially those struggling with the constant question of priorities in the use of limited resources, major emphasis was being given to the problems at the farm and "first" market level. With such wide differences in viewpoints and areas of emphasis of research and extension programs, a dialogue about relevance has prospects for long tenure.

Rather than delving into types of university research and extension activities that should be given emphasis, perhaps a more important question is, What can agricultural economists do to promote progress in agribusiness? Admittedly, this extends our parameters beyond university responsibilities and encompasses a broader base, including the public sector and its responsibilities toward improving the efficiency and effectiveness of the private sector. Economic intelligence, especially market intelligence, is most important to the operation of any business.

As a working economist in an agribusiness firm, it is my opinion that land grant economists are doing a very poor job in supplying agricultural firms with economic intelligence. There is no comprehensive and systematic approach to providing such intelligence. While some very fine monthly publications on outlook information and/or economic newsletters exist, the effort is largely haphazard and coverage of all facets of agribusiness is left to chance. In most instances, each professional proceeds largely independently. There seems to be no organized effort to create a team approach to the whole waterfront of economic intelligence needs. Badly needed is a nationwide approach to assessing

the economic intelligence requirements of agribusiness firms and a coordinated effort nationwide to meet these needs.

College economists—teachers, researchers, and extension specialists—often have never had much contact with the real world. Most have only a textbook understanding of the firms and marketing system. An economist can learn as much, if not more, about economic phenomena and how our economy functions from actual contact and participation in economic activities as from detached studies. No person should get a Ph.D. in marketing (or even farm management for that matter) until he or she has established credibility in a real world situation. This would require internships with business firms or in a real life operating situation in a public agency. While many departments of agricultural economics are offering programs of internships or off-campus arrangements for learning-earning programs, especially designed for undergraduate students, there are pitifully few arrangements for internships in industry for Ph.D. candidates. Moreover, there is great need for post-graduate internships that could be awarded to teachers, researchers, and extension personnel to undergird their level of expertise with real life experience.

I recognize that the research work and thinking of college economists are most important in establishing the rules of "economic games" in our economy. State legislatures and commissions rely heavily upon them as a source of reliable and relevant information. Public agencies in this arena of "economic games" are often just regulatory agencies and develop a dangerous bias insofar as adjustments in the rules are concerned. With the role of government at all levels increasing, academic economists can easily go off "half-cocked" unless there is sufficient interaction between them and the business community for economists to fully understand the concerns of the business community and the framework under which businesses are forced to operate. This is another reason for requiring internships in business for those who are to regulate business or work for business.

On the other side of the coin, large agribusiness enterprises can and do have highly qualified professionals on their payrolls. They provide expertise once only available in a few corporate enterprises or educational institutions. This evolving situation means universities must maintain closer touch with industry to maintain their relevancy. Some research and teaching or training must be done by industry, but universities must prepare personnel and guide long-term research efforts. Just as it is essential that internships be provided to students, researchers, and extension workers, it seems vital that some reciprocity should be permitted by bringing industry economists back to the campus for sabbaticals or, perhaps, for shorter stints in research and teaching assignments.

Conflicts between University Activities and Agribusiness Programs

Based on my own experience, there seems to be little real conflict between university activities and programs of agribusiness firms. But, since we are discussing relevancy again as a part of the AAEA's program, some areas of conflict are evident and becloud relationships. Generally speaking, where such conflicts exist, they are not all-encompassing and in many instances involve personalities rather than a whole department. Conflicts which do exist normally occur because universities and agribusiness firms go their own separate ways without a coordinated effort. University research so often does not fulfill basic objectives which meet the practical needs of the industry. Thus, agribusiness firms perform their own research which often is considered to be less "pure" by college professionals. For example, my own organization, together with other regional cooperatives throughout the nation and Canada, has research farms for testing and evaluating feed rations, medicinals, farm chemicals, a multitude of farm supply items, as well as for developing new strains of grains and forages, all of which involve economists as members of research teams.

Occasionally, a university uncovers evidence contrary to that reported commercially. When this happens, it is a signal to both parties to double-check their methodology and results, and it serves as a positive force for research in general.

Typical of the type of conflict that can arise is the result of land grant production specialists making recommendations without having received the assistance of economists in providing data on the economics of handling and storage costs of fertilizer materials at the retail level. For instance, in the marginal mois-

ture areas of the western Dakotas, it might be shown by research that anhydrous ammonia may perform well on rangeland and small grains. While ammonia is a cheaper product to manufacture, that fact does not necessarily mean it will be the lowest priced material to apply. A dealer must invest in special storage, application equipment, and additional labor and energy to apply the material. In areas where bulk-blending plants already exist, the higher priced dry urea fertilizer may still be applied at a competitive price with existing equipment and manpower.

Probably the most controversial conflict today is concerned with the role and growth of agricultural consulting firms and how these might conflict with university faculty members who also, in some instances, engage in consulting. When extension service and research people consult and advise farmers, large producers, and business firms, they provide rather unique services which in some cases could be better handled by consulting firms. For example, individual feedlot operators are provided information unique to their particular operations by extension workers without fee and, in other cases, university personnel engage in consulting arrangements with feedlot operators of the same size. In situations of this type, a possible conflict revolves around the natural concern an administrator has over how much professional time can legitimately be devoted to a problem unique to a single firm. Just how far can a college go in making one-time studies and in preparing unpublishable reports that are made available only to firms whose specific data have been used? To the extent that agribusinesses want "free" consulting and universities want "free" publishable information, this can be interpreted as an area of conflict.

In the future just as in the past, there will be conflicts between economists on the one hand and farmers, farm leaders, and industry people on the other, much of which will be totally unnecessary. As scientists, economists should be able to disagree without being disagreeable.

Potential for Joint University-Firm Research

Joint university-firm ventures have long been envisioned as being highly desirable and having unlimited potential. However, it is a type of activity that is more or less in its infancy. Someone needs to give thought to developing more useful ways of interaction between business people and researchers. Business people are not satisfied and they do not think it is enough to be asked what they believe to be research needs and problems. Would it not be better to discuss important decisions to be made by private firms and public agencies and what kind of new knowledge is needed for intelligent decisions? And, further, would it not be useful to discuss the goals of firms and the goals of society in an area of activity and what needs to be known to develop optimum systems or strategies, with differences in goals and values frankly discussed? Without such dialogue, researchers tend to become too immersed in their ivory tower theories and lose touch with reality.

Joint university-firm research has not been used as much as it should because university personnel are frequently not problem-oriented. In the future and because of budget-tightening processes, I firmly believe university people will become more concerned with the joint university-firm approach as they become more aware of constituents who can help them. Frequently in the past, academic people have had sufficient funds that enabled them to ignore nonacademic opportunities.

Probably the most vexing and difficult problem confronting joint research is related to time and scope of research undertaken. Whereas the university usually looks at the longer-range point of view, industry tends to emphasize the short run. Moreover, industry interests often by necessity limit the scope of a problem to a few alternatives, as opposed to the general consensus that university researchers should consider a much broader range of alternatives. If a proper perspective is maintained by all concerned, there should be no conflict between these points of view.

With scarcity of public funds, agribusiness firms should share the costs of joint research activities. In turn, agribusiness firms will be interested in projects that are regional in nature, and this means many administrators will have to compromise on the present, rather hard-nosed, opposition to research funding outside their geographic boundaries. Many business firms make grants to university and extension research and from these is expected maximum mileage. In this regard, industry may expect more than is sometimes possible and does not always recognize problems faced by

researchers in finishing projects that have been inadequately funded.

A good relationship between universities and agribusiness firms generally is possible if firms are organized in trade groups that invite extension and research people to participate in their activities. My personal appreciation and understanding of such benefits has resulted from my sixteen-year affiliation with the market research committee of the American Feed Manufacturers Association. Just last year, for example, that committee was hosted by the Department of Agricultural Economics at Ohio State University with key research and extension people prominently involved in the two-day program.

Because of a recent experience with an educational pilot project, the agribusiness firm I represent is convinced of benefits that can be derived from joint university-firm research activities. Following extensive planning by a multistate committee made up of a state extension specialist from each of the five states served by Southern States Cooperative, two representatives of the Federal Extension Service, a representative of the U.S. Department of Agriculture's Farmer Cooperative Service, and the President of the American Institute of Cooperation, this committee worked with key staff from our retail operations and from personnel and management training. In the initial planning sessions, the chief executive officer, the assistant general manager, and the executive in charge of retail distribution were included in the deliberations. Between July 1972 and September 1973, the team from the public agencies conducted a total case analysis of one local farm cooperative in each of the five states. As a result of these studies and the identification of problems, the extension research team and the Southern States staff team prepared a program format and subject matter for seminars which were held for all local managers, the regional staff, and selected central staff, or approximately 300 individuals. There were three seminars with eight professors involved. These were not programs the extension service built on its own. Southern States had a major input and say-so as to what was needed. Each seminar was a school on managing, to teach managers to grow with the business so it will not level off in gross volume or even deteriorate. For the fiscal year following the seminars, remarkable improvements in cost control and operating efficiency were reflected in lower handling cost per unit. The lower handling cost, coupled with greatly increased volume, produced the largest net savings for retail points in history.

Without question, the research-based seminars or workshops contributed much to closer control over expenses and more intelligent management. The extent of the contribution would be difficult to compute, but records show the organization handled 26% more dollar volume on 11% more dollars and salaries and 3% more employees. Most of this is attributed to the training service. Not only has the efficiency of our retail distribution system been improved, but through such improvements we have been better able to serve our farmer members and enhance their farm income through greater patronage refunds.

This benchmark effort in joint activity is now being replicated throughout the country for the benefit of other agribusiness firms and the farmers they serve.

Agribusiness Better Served by Extension

The orientation of extension economists toward agricultural industries is saving the colleges of agriculture from a rather complete isolation from agribusinesses. My reference is to extension specialists rather than to extension field staff. The latter who operate on the county level are deeply involved in administration of federal projects and have little time or expertise to offer, even to smaller business firms.

I do not speak for myself alone when I say the majority of economists in agribusiness firms feel that agricultural economics as practiced on the university campus virtually has "no market" for its research—other than among other university economists. I am concerned that too many of them have lost interest in farmers and in farmer businesses. In the current vernacular, their intellectual "high" seems to attain a level of satisfaction through quantitative analyses of masses of data, which provide the opportunity for constructing economic models, utilizing computers, and thus keeping busy without bothering anyone.

Having served on a recent ad hoc committee for evaluating the *Journal,* I feel I have a good reading of viewpoints about the *Journal,* not only from industry agricultural scientists, but from land grant research and extension

personnel as well. There definitely is a strong feeling that the *Journal* is not the place where relevant research is reported, and few if any decisions are reached by agribusiness firms on the basis of *Journal* articles.

Because of the lack of communication between the "doers" and "users" of research, I am firmly convinced the "ivory tower" characteristics of some university research is primarily due to the fact that the potential users do not darken the door of the researcher or the research administrator. Thus, we have highly theoretical investigations and too much untested research. Theory definitely has its place, but it should be tested in practice. Theory should be used as a tool and not be viewed as an end in itself.

Summary

In summary, it is my view that university research and extension activities that improve the knowledge of agricultural producers do benefit agribusiness firms directly and indirectly. Our continued discussion of the relevance of such activities is a reflection of great differences in viewpoints on needed emphasis, a segmentation that cannot provide the economic intelligence so badly needed by all facets of the industry of agriculture. Conflicts between university activities and agribusiness programs do exist, but are not insurmountable if communications are improved and if all concerned recognize that relationships conducive to a coordinated effort can be reached only by traveling a "two-way" street. By overcoming such conflicts, perhaps the doors will be opened to greater potential for joint university-firm research. Finally, extension economists—through their research and related activities—are providing the most relevant services to agribusiness firms. Campus research of agricultural economists, especially that reported in the *Journal*, does not offer a major input to decision making by agribusiness firms.

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Agricultural Economics as an Aid in Management Decision Making

Carroll G. Brunthaver

The subject of this paper is the contribution of the agricultural economics profession to the management decision process in agribusiness firms. It covers the importance of agricultural economics training in management, as well as the importance of agricultural economic research including in-house and university programs. My frame of reference is experience with an international marketing firm dealing with processing, domestic distribution, and exports. My bias should be understood—not that I am a complete captive of my environment, but I am looking at this primarily from the point of view of a firm with a strong applied research staff. Consequently, the need for applied research conducted at the university is less evident to me than if I were in a firm without such capability.

The importance of agricultural economics training to the decision maker should be evident. The primary function of an agribusiness marketing firm is the allocation of food and fiber from the time of harvest throughout the ensuing year or even years, and it seems imperative that the decision makers in such firms be trained in the basic concepts of economics. The marketing decisions, especially in food, must cope increasingly with a more sensitive worldwide production and demand. Insulative stocks that can forgive bad marketing decisions no longer exist and marketing decisions must call upon the best theory, information, and analysis possible.

The prospects for economic recovery in various countries around the world, the prospects for inflation, and the translation of this into purchasing power, and effective demand for basic agricultural raw materials can be best understood by those trained in the rigors of economic principles.

The amount of training and where and how the individual receives his training is not nearly as important as the type and quality of training the individual receives. The type of training refers to basic principles versus applied "how to" courses. The quality of training refers to the capabilities of the instructor and the priorities placed on teaching by the colleges. Training is most useful when the individual is introduced to basic concepts that broaden his learning horizons. Marketing courses that stray too far from basic principles do not, in my opinion, contribute as much to the education of people we think will be successful in our firm as do courses which concentrate on basic tools that can be applied to endless types of situations.

The successful economists in agribusiness today must have a firm understanding of economic principles, be able to relate those principles to the day-to-day problems, and be able to think, reason, debate, communicate, and work in harmony with those around him. This training can best be done by specialists in the art and science of teaching who are attracted, rewarded, and held in the teaching profession and not by research assistants or teaching assistants or high powered researchers who are obligated to carry a certain teaching load.

The greatest contribution of the agricultural economics department in the United States today, by all odds, has been and continues to be education and development of the scientific and managerial talent that has subsequently contributed to the strength of the U.S. economy. This may or may not be fully understood by our colleges or the legislation supporting college funds today. The popular slogan, "publish or perish," is an indication that it may not be as well understood as it should be.

Importance of In-House Economic Research

The contribution of in-house research depends on the attitude of management. Is management receptive to research results? Is management willing to support, encourage, lead, suggest, and use the research? If not, I would

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not suggest a large in-house research budget, because it will not thrive and the results will probably be very expensive and not very useful.

Given the proper environment for research within the firm, there are some problems so critical to the success of the firm that management needs their own researchers to constantly live with, develop, improve, recognize the limits of current analysis and, in general, give that problem undivided attention. Such attention and capability can pay returns far greater than may be apparent. In addition, some research efforts or problems require full-time attention, and it may be more efficient for the firm to do its own analysis.

There is often an interchange between researcher and operating personnel that is possible only with in-house research. Such interchange not only increases the value of the research but also assures that the results are received, understood, and used. When our researchers work with merchants in defining the storage surplus or shortage by areas, it becomes the merchant's work as well as the researcher's, and the operating people are more likely to understand and use the material. There are few secrets in agribusiness these days, but there are a few which need to be protected by in-house economists.

Retention of good researchers is essential. The most valuable asset a marketing firm can possess are good researchers who understand the firm's research needs, who have developed the source data and the models, and who have the respect of the operating people as well as management. It is one of management's greatest responsibilities not only to keep that individual, but to see that he continues to grow and develop. That job cannot, in many instances, be left to a consulting firm or a university department but must be personally and directly supervised.

Some research requires a scale of operations beyond the reach of a particular firm. To secure economies of scale, it is often necessary to go outside. This can often be accomplished most efficiently if there is an in-house research capability to communicate and work with the outside group. How can research results be communicated? I almost want to say by osmosis, meaning that management must be intimately involved in the research effort, and as results are available, management must understand the assumptions, limitations of data and analysis, and anticipate the results of the work.

Training for In-House Researchers

The training for in-house researchers should consist of a sound basic understanding of economic theory, principles, and fundamentals of quantitative analysis. The researcher must be equally aware of the strengths and weaknesses of economic and statistical analysis. Also, the researcher must be trained in logic and communication skills, and he must be able to get along with and motivate others.

The computer is now an accepted fact of life and training in the use and possibilities of the machine is helpful. An awareness of the possibilities of total data base integration where research data can be captured as a spin-off of a properly designed management information system for the firm is also useful.

Increasingly, as we operate in a world economy where events in Taiwan, Korea, Indonesia, Africa, the USSR, etc., exert more and more pressure on management decisions and their research needs, the ability to speak a foreign language takes on added meaning and value.

University Research

The importance of university research is greatest when it concentrates as closely as possible on basic research. The economic problems of today are very complex. Solutions require a fundamental understanding of economic principles. What is the nature of the price and income elasticities of demand for wheat and beef? What is the effective demand for cereals in the world as economies grow? A better understanding of the cereal supply function would be helpful. We have based some very important decisions (as a nation) on some pretty poor analyses of the nature of the production capability of the United States under full capacity. Basic research on quantitative analysis tools is helpful.

I do not wish to be misunderstood. I am not against applied research—that's my profession. What we are talking about is the unique role of university-funded research, and the question arises, If the basic research is not developed here, then where?

I am arguing for added priority to basic research. Applied research is fine, useful, and

needed, but it can be done by many groups. Basic research cannot. While I may be very pleased to have one of our economists develop a breakthrough in basic demand analysis, time priorities cannot be assigned for such work.

In the physical and biological sciences, the need for basic research is probably more evident. New metals, chemicals, and wheat all require an attention to basic research. In economics, we may feel that a food reserve policy, farm legislation, or export controls can be developed without much attention to basic economic analysis.

I remember vividly the statement by someone who should have known better that U.S. dollar devaluation was not inflationary. Price controls were applied to beef, pork, and broilers without sufficient attention to the economic repercussions of such actions.

The "ivory tower" has bad connotations, especially for those who have no concept of the foundation building required for sound economic analysis. The public probably is not ready to support theoretical, basic research. Legislators are practical people who often do not see the significance of basic research. Businessmen tend to get involved only when they want some applied research work done at the university. However, that should not deter those who understand that basic research must provide the foundations for more complete and accurate economic analysis in the future.

Communication of University Research

Communication of basic research analysis is a major function of the professional journals. In addition, increased interchange between the applied research personnel and the more basic university types would probably benefit both. We are experimenting with a program of supporting a university professor on a sabbatical leave for a one-year program of working in research facilities. I think this will have many side benefits.

University-held and industry-sponsored symposiums on more basic research may be of considerable interest and benefit to both the basic and applied researcher. Industry sponsorship of basic research with little expectations of short-run returns, perhaps, should receive more attention.

Finally, if the profession is to continue to make maximum contributions in the future, additional effort should be made in terms of industry sponsorship and legislative support for more funds to attract, hold, and reward the teaching specialists. This should be accompanied by an increased understanding within the profession that the major contribution of the university economist will be in teaching, and programs designed to increase the effectiveness of teachers will pay important returns in the future.

Economic and Social Information for Rural America (W. Keith Bryant, Cornell University, Chairman)

Strategies for Long-Run Investment in Rural, Social, and Economic Statistics

Bruce Gardner

This paper originated from the ongoing efforts of the American Agricultural Economics Association Task Force on Social and Economic Statistics. It may be viewed as an interim report on a continuing search for promising investments in information systems. Although it draws heavily on discussions and preliminary papers of the Task Force to date, this paper does not represent a concensus or formal statement of the group. The discussion is divided into two main parts: the needs—or, as it may more naturally and accurately be expressed, the demands—for data; and the alternatives available for meeting these demands in the face of inevitably limited resources—the supply side of the picture. Throughout the discussion I use four closely related yet distinguishable terms: data, statistics, knowledge, and information. These terms have widely overlapping uses, so it is useful to assign each a specific meaning for present purposes. First, data are statements of fact about the world, while statistics are data put in numerical form. The statement that Mr. A. owns a car, a house, and a boat is a datum but not a statistic. The statement that these items are worth $60,000 is a datum and also a statistic. This corresponds to the dictionary distinction between the terms.

"Knowledge" is used here not in the sense of certainty or justified true belief, but rather as data applied so as to render alternative hypotheses about the world more or less probable. This is undoubtedly a philosophically unsatisfactory definition. The point is to emphasize that knowledge is the end product which results from the chain of events beginning with data.

Information, according to Webster, is knowledge obtained from communication or investigation. Since what is communicated are data or statistics, allowing "information" to denote a subset of knowledge makes the term practically redundant. The present discussion follows Dunn (1974, p. 20) in using "information" to denote a process. Specifically, it refers to the process by which statistics are produced and used.[1] In this terminology, an information system refers to the established processes by which data are collected, transformed to statistics, and communicated to produce knowledge.

Long-Run Demand for Statistics

The demand for statistics is derived from the demand for knowledge. To explore the long-run demand for rural economic and social statistics, it is therefore helpful to consider the long-run demand for knowledge about rural areas and rural people. Why is there demand for such knowledge? There are two main answers. One is to treat knowledge as an end in itself. Knowledge is a final good, like food or housing. It satisfies our curiosity, a need at least as worthy as satisfying our thirst. The second is knowledge as a means or a tool. Knowledge in this sense is a necessity for private planning and for the development and implementation of public policy.

The formulation of short-run demands for knowledge requires the intelligent consideration of our current ignorance. Discussion of the

The discussants for this sessions were Thomas F. Stinson of the Economic Research Service, U.S. Department of Agriculture, St. Paul, Daniel W. Bromley of the University of Wisconsin, and Richard Tauber of the National Academy of Sciences.

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[1] This usage conflicts with that in the economic theory of information (Stigler), which would be properly titled in the terminology of this paper the economic theory of knowledge.

long run requires in addition projection into the future. For knowledge as an end, to predict future as distinct from present demand seems impossible. Therefore, I will consider only knowledge as a tool, and even more narrowly, as a tool for social policy.

One might think that demands for knowledge for future social policy would not be difficult to predict because human goals and the problems faced are relatively stable. But even when the political framework and human goals and problems do not change at all, the social policy that emerges is likely to vary greatly over time. One main reason for such variation is changing knowledge due to progress in social science. A good example in economics is the rise of monetary and fiscal policy since Keynes. The knowledge and, therefore, the statistics demanded by researchers and policy makers have changed since the 1930s even though goals concerning unemployment, inflation, etc., have not. Similarly, knowledge gained from past policy efforts in the area of farm price supports, for example, is bound to influence future policy even if final goals stay the same. Thus, it is not clear that constancy of human problems and aspirations helps much to simplify prediction of demands for knowledge when social science is changing.

Perhaps a more promising approach is to consider future demands for knowledge by social scientists. This is not to say that there is any fundamental opposition or conflict between social scientists and policy makers, only that the derived demand for statistics is more likely to change due to progress in social science than to foreseeable change in policy goals.

In taking a long-run view, it is important to look beyond the statistics needed to describe the immediate state of the world to data that allow progress in discovering causal connections or structural relationships. Knowledge about structural relationships is bound to require more expensive investments in statistics than does knowledge about the state of the world. For example, it would be much cheaper to get statistics to estimate the longevity of farmers than to get statistics that allow us adequately to explore the determinants of longevity. On the other hand, knowledge about structural relationships, though costly, can be valuable, even essential, in the long run for policy formulation.[3]

Moreover, knowledge about structural relationships is helpful in the efficient formulation of further demands for statistics. Recalling the earlier distinction between data and statistics, statistics are productive because they bring data under control. They do this by leaving out data not pertinent to the issue at hand—by abstraction. There is a danger in abstraction, illustrated with reference to another topic in communication by this remark credited to the diplomat Talleyrand: "Man was given the power of speech in order that he might hide his thoughts." Likewise, statistics, though intended to be revealing, may actually hide the facts. One aim of long-term investment in statistics should be to minimize this problem, and a most useful aid in accomplishing this objective is theory adequate to help select intelligently from the infinite data around us.

A Problem for the Derived Demand for Statistics

What is judged to be data worth collecting depends on one's prior view of the state of knowledge concerning the structural relationships. For example, in discussing the backward state of research on returns to human capital in Britain, Blaug puts forth the following hypothesis: "The general skeptical attitude in this country [about viewing education as investment] may account for the failure of the British Census of Population to secure the sort of information about earnings by age and education which is regularly collected by the decennial population census in the United States." (p. 205). Without considering the merits of this particular case, note the dilemma created by it: an issue in social science cannot be investigated because the requisite statistics do not exist, but the requisite statistics are not produced because an investigation of the issue is thought to be misguided (or the problem is insoluble or trivial). Such dilemmas would not be important if all social scientists agreed on the present state of knowledge in their fields, but they do not.

This discussion leads immediately to one sort of useful statistics for future social sci-

[3] For example, consider the policy variable "the legislated agricultural minimum wage." If the causal connections between this variable and the final variables it influences (intentionally and unintentionally) were fully known, it would be bound to influence the development of minimum wage policy. As another example, the question as to whether rural development legislation should contain provisions to encourage industry to locate in rural areas and what form such encouragement should take, turns, largely on our understanding of rural labor and capital markets and the impacts of industrialization. For a discussion that illustrates how social science results can influence what rural development policies are preferable, see Nolan and Heffernan.

ence, namely those necessary to test hypotheses whose validity is currently in doubt or dispute. However, the specification of statistics necessary to discriminate and choose among alternative hypotheses is difficult in practice. Moreover, it can only be done adequately in piecemeal fashion, by considering various problems and hypotheses individually. In Task Force discussions and in papers written by its members several areas were given special attention (Bawden and Kershaw, Bryant, Daft, Edwards, Gardner, Madden, Vlasin). A brief summary follows of two of these areas which yield insights into problems in the long-run demand for statistics.

Statistics Pertaining to Rural Development

This area is the most difficult of those studied in which to formulate practically realizable long-run data demands. The demand for knowledge is strong both from policy makers and from social scientists. What is weak is our ability to formulate the derived demand for statistics. The theories and hypotheses that guide social science in these areas are too vague. It is not well established even in theory exactly what rural development is, although this is surely a prerequisite for specifying data demands. This is first and foremost a conceptual problem. The central concept is related roughly to the "quality of life," which comprises not only material well-being but also such nonmaterial attributes as state of health and various social, political, and religious opportunities and attitudes. Research on social indicators may yet provide a framework that will allow practically realizable demands for statistics to be distilled from this conceptual mélange, but it has not done so yet.

Statistics Pertaining to the Value of Human Time and to Human Resources

The development in recent years of a theoretical framework for the joint analysis of the price of time and the price of goods has generated a whole new set of demands for statistics (Becker). Especially important in agriculture is the nonmarket use of the time of rural families.[3] Indeed in seeking to understand why the "farm family" has become a conceptually obsolete unit of observation (i.e., why this classification does not dichotomize the total population as neatly as it once did), the main statistics needed are those which will facilitate the investigation of the allocation of time to off-farm activities by farmers and members of their families.

The demand for statistics to be used in the testing of hypotheses about returns to human resources brings in another type of information: data pertaining to institutions. The main institutions here are markets. Understanding returns to rural human resources means primarily understanding markets for human resources. A special problem in agriculture is the great importance of earnings from self-employment. In this case, returns to human resources are not themselves contracted prices but rather are implicit prices determined on the demand side by farm product markets and on the supply side by nonfarm alternatives for the use of these resources. Thus, it takes a great deal more data to generate reliable estimates of labor returns in farming than it does, say, for wage earners in manufacturing industries.

Though economists have a natural tendency to concentrate on markets, there are also demands for data pertaining to other institutional arrangements such as tradition, voluntary associations, and government. As discussed with reference to rural development, there is a lack of theoretical guidance in these areas. The nonmarket institution for which data demands are most helped by social science theory is the family, thanks to the analytical home economics put into the mainstream of research by Becker and Schultz. The existence of rather precisely defined theory in this area has been invaluable in sharpening up demands for knowledge and pointing the way to specific derived demands for statistics.

Generalizations about Long-Run Demand for Statistics

In considering the long term, the question remains: What social and economic statistics will be most useful for future social science in general? In one respect this task is impossible. It could not be accomplished without knowing

[3] Bryant notes that "if agricultural economists are to be distinguished from general economists one distinguishing feature might be our understanding of self-employment households: i.e., family-farms. Yet, when I search the literature for models of self-employed households I find it ironic that they have been developed typically by general economists confronted with peasant agriculture. Agricultural economists, for good or ill, blithely assume the family part of the unit away!" (p. 3).

what the future theoretical framework of social science will be. The hypotheses that future researchers will want to test will arise from this future framework, but we cannot know what the future theoretical framework of social science will be. If there is to be future progress in knowledge, it is a contradiction in terms to say that we know now what that progress will be. Since we cannot in general predict what hypotheses future social scientists will want to test, how can we say anything generally useful about long-term investments in social and economic statistics for rural areas?

The question can at least be narrowed by applying this remark of A. N. Whitehead: "To see what is general in what is particular and what is permanent in what is transitory is the aim of scientific thought." (Feather, p. 1). If this statement is correct, we should ask what data, out of the host of transitory phenomena we observe, are likely to be most helpful in revealing "what is permanent." And which of the many particulars will be most fruitful in generalization?

Consider the distinction between (*a*) knowledge of historical facts and (*b*) understanding the causal connections among them. Statistics yield returns under (*b*) by allowing explanatory hypotheses about the facts to be tested and acted upon effectively. Although (*a*) seems logically prior to the theorizing under (*b*), in some cases the "facts" themselves have theoretical content. Consider, for example, measuring the stock of human resources. The number of people is a "bare fact" but a moment's reflection reveals that the number of people is not a good measure of the stock of human resources. What other facts do we need to compare heterogeneous people? Some candidates: height, weight, strength, I.Q., and age. The selection of these to measure the human resources embodied in a person, or family, or larger political unit requires a theoretical framework, which has come to be known as the theory of human capital.

In the area of human resources, the concept of human capital brings out two aspects of "what is general": capital yields returns, and it can be generated by investment. Therefore, statistics on human resources should pertain to market and nonmarket returns and to activities that will generate future returns. Consider, then, "height" as an element in a measure of human resources. Does it produce returns? Can it be changed by investment? In both cases the evidence available suggests quantitatively minor effects.

This case brings out again the crucial importance of having a solid theoretical base. Good theory leads to concrete, conceptually well-identified demands for knowledge and for statistics. An absence of theory, or ad hoc ill-specified theory, leads to chaotic data-collecting efforts which yield low returns in the form of new knowledge. Unfortunately, in some areas where the general demand for knowledge is greatest, the theory is weak, and it seems quite impossible to specify long-term demands for statistics.

What does this imply about promising investments in these areas? Perhaps the main lesson is that the statistics generated should be adaptable to various treatments as the concepts that researchers and policy makers operate with change. Adaptability is enhanced by having statistics available for microunits and for microconcepts. Microunits means individuals. When data are available for individuals, an investigator can construct larger aggregates—families, communities, occupations, etc.—as seems fitting. But if data are available only in already-aggregated form, the individual is lost forever. "Microconcepts" refer also to disaggregation. For example, instead of data on the concept "income," it is better to have data on the building blocks of which income is composed: wage rates, hours worked, returns from other specific sources. This disaggregation is especially valuable when economic concepts are uncertain or changing. For years there has been dispute about how to account for unrealized real wealth increases of farmers in measuring their well-being. Obviously, it would enhance economists' ability to cope with the outcome of this issue to have statistics on real wealth gains and ordinary income separately for individuals, whether current "best practice" were to lump the two together or omit capital gains.

Social scientists and policy makers have demands for statistics which are insatiable at a zero price. Since data are in fact costly, it is necessary to specify priorities for data demands. This is a difficult problem even for short-run demands; for the long run it seems quite impossible. In the area of registering long-run data demands, the most fruitful approach is probably not a list of proposed improvements but some institutional innovation. Some very crudely sketched possibilities follow.

(*a*) Establish a complaint window, some organized way to get the views of social science researchers fed into the agencies which produce statistics. (*b*) Appoint a standing committee. This committee would not be a study group like our current Task Force but would constitute a continuing liaison between data users and data suppliers. As Dunn (1972) notes in his comment on the 1972 parent committee report, the problem of conceptual obsolescence of data cannot be met by a onetime revision. The problem is continuous. (*c*) Organize a new demand-simulating institution for data wants. A chronic problem is that discussion tends to be in terms of "wants" and "needs." It leaves out the willingness to pay that lets demands in the market sort themselves out "as if by an invisible hand." Is there any way we can put an element of dollar voting into our data votes for publicly produced statistics? (*d*) Create small scale task forces to address themselves specifically to concepts that have become particularly troublesome. Examples are the definition of "rural" (i.e., exactly what subset of the whole U.S. population are rural, social, and economic statistics supposed to pertain to?), the concept of personal income to be used, the the appropriate social indicator(s) to measure rural development. Each of these requires complex and detailed theoretical and practical consideration by scholars with the expertise in various areas. Such task forces might therefore contain representatives from academic departments, USDA, and data-gathering agencies. On the other hand, it is possible that the optimal size for such a task force is one person.

Further work on these and other possibilities for institutional innovation is a major area of unfinished business for the Task Force.

Information Systems and the Supply of Statistics

The notion of an information system can be made very general. In the usage of Dunn, an entire social system may be viewed essentially as an information-processing system (1974, p. 39). Hayek views the price system as an information system; it is a system by which the knowledge possessed by thousands of actors each ignorant of what most of the others know can be communicated and acted upon simultaneously (p. 86). It is the price system as an information system that makes a market economy work. I wish to restrict the notion of an information system, following the earlier definition in this paper, to refer to consciously controlled, publicly established institutions by which data are collected, transformed to statistics, and communicated to users.

The Information System as a Collective Enterprise

Knowledge can be and is produced and used by individuals as well as collectively. But knowledge both as an end and as a tool has important public goods aspects, and it is hardly questioned that an information system is an appropriate governmental enterprise. Since this means that the information system is operated and financed by means of the coercive power of government, the production of statistics gives rise to recurring long-run problems inherent in collective action.

One such problem is assessing the value of publicly generated knowledge as an end in itself. Apparently in Francis Bacon's day, it was a novel insight that knowledge is power, i.e., that knowledge is useful as a tool. Today it is doubted that knowledge has any other value. Knowledge as an end in itself shows up badly in benefit-cost calculations. My own reaction is to shudder as Senator Proxmire cites with evident disapproval the thousands spent by the National Science Foundation to finance the investigation of the mating habits of Polish frogs. Not that the particular case is important, but the approach taken suggests that knowledge as end in itself is rather lightly regarded. Of course, it may be that the value of knowledge as a public good is very small, and if anybody wants to discover the mating habits of Polish frogs, he ought to spend his own money on it and keep his webbed feet out of the public trough. The point here is simply that a difficult valuation problem does exist.

Another issue in a public information system is violation of individual rights. This problem is most obvious with respect to the census, where one is required by law to answer questions. Even voluntary surveys may impinge upon an individual's right to privacy. Having looked this issue squarely in the face, I propose to pass on.

Centralized and Decentralized Information Systems

The existing information system consists of two quite different parts. The first is the centralized organization that constructs, con-

ducts, and disseminates our censuses and periodic national surveys. The second is a decentralized "system" (hardly a system at all, the coordination is so loose) in which individual researchers and policy analysts with grants from the federal government and various other sources collect limited survey data for specific research or policy purposes. The pertinent question regarding investment in information systems is: Which will yield the highest rate of return, expansion of the centralized system (e.g., asking additional questions in the Census of Agriculture or in the U.S. Department of Agriculture periodic survey) or of the decentralized system (e.g., additional grants to state experiment stations for data-gathering efforts of their own design)?

Several instances have been mentioned above in which the statistics of our censuses and national surveys as published are inadequate to test hypotheses being developed. These deficiencies might be remedied by investments in statistics that would allow wider use of such data in hypothesis testing (for instance, that in the USDA farm labor survey questions be asked about the age, schooling, and work experience of farm workers). But there are so many such possibilities, each of which might prove useful in the development of our understanding of economic events in rural America, but which again might not, that it would be hard to justify any very large expenditures.

It further discourages one from recommending massive new investments in the centralized data system to reflect that, after all, great progress has been made in empirical research in many areas without using any census-type statistics but relying on specialized, small-scale (relative to the census, anyway) surveys. Many of these studies could have been done with census-type data if sufficient questions had been asked and the data published in suitable form. But it is questionable whether this would have been a more efficient method of data collection than was actually used.

To give a specific example, it is clear that annual money income gives a very imperfect picture of a rural family's economic status, but to construct a better estimate is difficult and expensive even for a small sample. In such cases it could be a mistake, say, to ask more detailed questions in the Census of Population so that more could be done with the "user tapes" of individual observations. These tapes are made from sample sizes in the millions. This makes the cost of even one additional question very large, and the sample size is far greater than necessary for most purposes.[4]

In contrast, a decentralized system has several advantages in providing data for social science research. It is flexible. Because it can accommodate small-scale efforts, the costs of error are relatively low. This will encourage data collection efforts based on minority or even crackpot models, i.e., a diversity of experimentation. On the other hand, by its nature a decentralized system will be less well coordinated. It will be difficult, if not impossible, to avoid duplication of effort and noncomparability of different surveys.

Moreover, in the pursuit of flexibility to avoid conceptual obsolescence, it would surely be a mistake to abandon all fixed definitions whenever an improvement can be made. To do so would be to cut off what limited ways there are for comparing present and past. For example, one of the most conceptually dubious distinctions the Census of Population makes is the threefold division between rural farm, rural nonfarm, and urban people. But the revisions so far implemented have not been a great improvement. In fact, researchers seem to be sticking to the old classification because it can be compared with similar groups from 1960 and 1950. It is hardly an exaggeration to say that for many uses of the residential classification, it does not matter too much how people are grouped, as long as it is always the same.[5]

It seems that a research question may be better served by the centralized data system at one stage (most likely the early stage when the simplest hypotheses are being examined) but by the decentralized system at another (when more sophisticated and refined hypotheses are being tested). For example, in the case of estimating the returns from schooling, census data were the first to be brought to bear on the subject. But for answering subsequent questions like: Is it more schooling that yields income or is it rather innate intelligence that is positively correlated with both schooling and earnings?, data from surveys in which I.Q.-type questions were asked became necessary. These data came from the decentralized sys-

[4] This fact is recognized by the Bureau of the Census. Their tapes include only 5%, 10%, and 15% of the individuals for whom data were gathered, thus throwing out the majority of the information collected.

[5] Not that keeping things "the same" is easy. For example, how should the dollar value of sales used to separate "real" or commercial farms from other farms be handled from year to year in order most accurately to "keep things the same"?

tem (see Griliches and Mason, Taubman and Wales).

An issue that arises on the supply side of any information system is the production of quantity versus quality of statistics. As the 1972 report of the AAEA Committee on Economic Statistics states, many of the specific faults of the statistics generated by all parts of our current information system are attributable not to an absence of numbers but to their reliability and congruence with theoretical constructs in hypotheses to be tested.

Another aspect of quality arises in the presentation of published data. For example, in studying the causes of inequality of farm income it is useful to know something about the inequality of land ownership since income is generated from resources owned. The Census of Agriculture in 1969 collected statistics on the value of real estate ownership for every farmer completing the full questionnaire. But these data are not published by value class of real estate owned, so that the inequality of ownership cannot be calculated.

Quality has costs, obviously, and it is by no means a foregone conclusion that a trade-off of higher quality data for a smaller quantity is a wise decision. As McKenzie and Tullock's reversal of the old commencement address saying has it: "Anything worth doing is not necessarily worth doing well." (p. 23). Nonetheless, there do seem to be some relatively cheap possibilities for improving the quality of rural, social, and economic statistics.[6]

Conclusion

The Task Force on Social and Economic Statistics has so far not arrived at any detailed, immediately applicable recommendations for long-term investments in information systems. On the demand side, it is possible to specify several areas where more and improved statistics would be valuable. But for long-run demands, especially where the theory necessary for guidance is weak, it seems that a list of data needs is not the most useful way to proceed. Possibly more fruitful would be a search for institutional innovation to reflect the data demands of researchers and policy makers more accurately. On the supply side, although we are not prepared yet to recommend specific investments in information systems, we have some ideas and are generating more specific ones.[7] The most promising prospects for future work by the Task Force probably lie in the area of producing suggestions for institutional changes to reflect more accurately the data demands of social scientists and policy makers and to respond more efficiently to these demands in producing useful statistics for rural areas.

[6] The general issue of the rate of return to more and improved statistics is itself a promising research area. A useful start has been made by Hayami and Peterson. In view of the fact that almost all of us who consider statistical reform tend to think of our task as being the discovery of which costly improvements to favor, it may be worth reminding ourselves that we have not yet shown that the optimal level of public investment in rural, social, and economic statistics is not less than is currently being spent.

[7] Two suggestions that seem promising at this time are beefing up one or more of the USDA's periodic surveys to provide a national panel to be followed through time, and providing an institutional mechanism for increased financial support for independent, decentralized data gathering.

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Economic and Social Information for Rural America: Priorities for Immediate Improvement

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The problems and issues related to the subject of this session are of staggering complexity. The major challenge is to impose some order on the whole mass and to identify priorities for constructive action. Of necessity, we have limited the topic to a more manageable scope. Within that scope we have identified several different priority actions, not the full array of actions that warrant immediate and important concern. This paper focuses upon rural development including natural resource use. It gives attention to economic development at the local, substate regional, and broader levels, and to information challenges requiring prompt action or consideration.

We have divided our presentation into five parts: a general framework or strategy for subjecting this topic to some systematic scrutiny; identification of some key problems or issues in rural America and tasks concerning them that serve as guideposts for judging priority actions for information system improvement; a discussion of the need to avoid implementation of narrowly conceived information systems designed for one purpose but that may become institutionalized and subsequently the basis for unintended decisions and uses; opportunities for supplementing current information systems that are basically sound but that have major gaps because of new policy issues or decision choices; and suggestions for new information systems or approaches, the exploration and development of which could begin immediately. In the process, we will draw upon findings and recommendations of members of the American Agricultural Economics Association Task Force on Social and Economic Statistics.

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Members of the Task Force have considered several areas of data or information system improvement. A number of discussion papers were developed (Bawden and Kershaw; Bryant; Daft; Edwards; Gardner 1973; Madden; Vlasin 1973). These background papers constitute significant contributions to the intellectual overhead for progress in this area.

The Task Force on Social and Economic Statistics for Rural Areas, however, has not collectively made a listing of priorities for immediate action. Thus, treatment of priorities here does not reflect a consensus. Rather, it is a perspective that includes contributions from Task Force members and from other sources.

A General Framework and Perspective

In his presidential address, James T. Bonnen gave us a synthesis of views "toward an improved information system for agriculture and rural life." As we reflect on Bonnen's comments and consider a plausible framework for guiding efforts at data and information system improvement, at least three categories of issues emerge. One pertains to the nature of problems that confront us as we approach information system improvement. The second concerns the purposes to be served by the data collected and the information system developed. The third pertains to the process by which an information system functions, including the organization or institutionalization of those functions.

In setting forth the first of these, namely the nature of problems faced, we find Dunn's insights to be most helpful. Particularly useful is his clear explanation of the three orders of problems in information system improvement:

> We are a nation confronted with serious, insistent social problems (first-order problems). . . . If we are not always sensitive to their nature, we are becoming keenly aware of them at all levels of social action. . . .

> Underlying these problems are a set of social information processing problems (second-order problems). The awareness of this fact, so far, is restricted to a relatively small group of social scientists and public policy makers. Yet it is the set of problems that must be dealt with before our urgent social needs can be served. Therefore, a major part of the problem is this gap in awareness. . . . There is a third-order problem . . . . a paradigm problem (inadequate concepts) that lies behind the information problem. (Pp. 66–67).

The three-order treatment reminds us that when we set out to improve data bases or information systems, we must go well beyond them. We must go back to the societal problems that give purpose to the information system and data and beyond into the concepts that underpin them and facilitate better articulation of problems.

We particularly stress that the problem-solving and opportunity-achieving context provides the major rational for information system improvement. In direct or indirect ways, an information system should help achieve human and societal well-being. Yet the effort to build information systems often proceeds independently with all the intellectual energy being used in the exercise of building classification schemes and other parts of the information system.

The second part of our framework deals with the purposes data bases and information systems are to serve. Gardner classifies the main uses as data for the development and implementation of public policy, data for private planning, and data for the progress of social science. Further, he draws a clear distinction between data needed to describe the immediate state of the world and data that allow progress in discovering the casual connections operating in the world.

Berry, in his treatment of alternative modes of planning and data requirements for them, specifies four data and information system purposes: (*a*) reacting to past problems and planning for present concerns—"Ameliorative Problem-Solving;" (*b*) responding to predicted futures and planning toward the future—"Allocative Trend-Modifying;" (*c*) responding to predicted futures and planning with the future—"Exploitive Opportunity-Seeking;" (*d*) deciding desired futures and planning for and creating the future desired—"Normative Goal-Oriented" (p. 174). The purposes are many and serve to underscore the importance of the clarification of purpose(s) prior to creation or modification of data bases and information systems.

The third part of our framework pertains to the process by which the information system functions, including the organization and institutionalization of its functions. Dunn provides a basic dichotomy that serves well: the data base or information system functions within a "performance mode" or within a "learning or development mode." The "performance mode" is basically static, sustaining managerial decision making, usually with goals specified and measurement of progress desired. By contrast, the "learning or development mode" is dynamic and capable of change, in which the goal of the decision maker is incompletely specified and the purpose of the information system is to assist the decision maker in specifying the goal in a progressively more complete form.

Another portion of our framework must of necessity be the structure or institutional setting. Gardner has suggested two, the "centralized organization" and the "decentralized system." The first is the centralized organization that constructs, conducts, and disseminates our censuses and periodic national surveys. The second is a loosely coordinated system comprised of individuals collecting limited survey data for specific research or policy purposes. To these two important structures others can be added, such as multistate regional units, the states and their state level agencies, the multicommunity and multicounty agencies, planning commissions and groups, and the metropolitan municipal or local governmental units. This added collection of structures is increasingly designing, conducting, analyzing, and disseminating the results of surveys. In addition, they are moving into data system creation and operation with surprising speed. Not to be overlooked are the private sector information systems and those operated by associations and groups.

In addition, there are data characteristics in information systems for rural areas that also constitute part of the framework. Included are the statistical unit for which data will be collected, the spatial aggregation of the data, the decision-making aggregation (the sectorization problem), the temporal aggregation (the way data are summed over time), the variables for which data will be collected, and the measurement units for those variables. These in turn lead to important questions of the quantity and quality (precision of data) and

the frequency with which data are to be collected.

This general framework, though rudimentary, provides reference points for identifying possible improvements in information systems. We cannot, in this paper, treat all of the framework components that are important in analyzing any one information system. Instead, we focus our attention selectively on such aspects as regionalization to solve social problems. Now we turn to some of the issues that members of the Task Force and others have observed as being important in economic and social information improvement for rural America.

Some Key Problems, Issues, and Tasks

In the treatment of problems, issues, and tasks, we give particular attention to certain aspects of rural development. We focus on local concerns about economic development, citizen preferences and objectives for development, job creation and manpower utilization, social problems in relation to economic development, regional and other units for development, resource base for economic development, and some policy interfaces.

Local Economic Development

During its formative stages, the AAEA Committee on Economic Statistics observed the central importance of local economic development for rural areas. Various research efforts in regional economics had led to application of input-output, shift-share, and other techniques for understanding overall growth of rural areas. Some progress has been made in identifying needs for local area data. A starting point had been established for devising needed improvements in rural area economic base data, particularly as they apply to output and employment by industries. The primary task appeared to be that of making data already collected available by refined small geographic areas.

However, Edwards observed confusion about growth, development, and progress and what they mean. The end in view appears to be an improved quality of rural life, but it is also vague. The definitional and measurement problems are major. Conceptual clarity is needed regarding development from whom or what, in what ways, at what levels of aggregation, and so on.

Judgment about what is important in local rural areas is changing. Edwards observes a changing view of growth as a curative, a changing belief in the extent to which farming and rural life are "fundamental," and changing views on benefits of economic development. There also are changing attitudes about the side effects of growth, the influx of new residents, the quality and importance of public services, and the use of public and private resources, particularly land.

Despite these changing perspectives about the impact of growth, there is the prevailing need for jobs, income, and human alternatives—the essence of development. The challenge is to sort these out in a systematic way to permit choices sensitive to human needs.

Local Citizen Preferences and Objectives for Development

The judgments about what is important are indeed changing and complicate the development process. There are, however, two additional complexities. One is the general lack by local and regional decision makers of information on what their constituents need, want, and will support. The challenge is to determine constituent preferences in a manner that can reflect the value they ascribe to preferred goods, services, and environmental amenities, their willingness to pay for them, and opportunities foregone by the provision of ones selected. Local and regional decision makers need such information to cope with possible development pressures, select among existing development alternatives, establish development priorities, and relate to the many federal and state governmental programs available. Typical planning processes today emphasize technical, physical, and economic feasibility of development efforts but miss systematic citizen input on perceived problems and on development needs, preferences, and priorities.

A second local and regional complexity is lack of agreement among leaders and constituents on objectives for development action. As development is practiced in many localities the leaders, citizens, agencies, and groups do not communicate clearly what they are trying to do. When they are in communica-

tion, they may not agree. Conflicts occur and persist. As a result, localities and their regions lack clear goals and targets for rural development. Total consensus is unlikely, yet the opportunity for substantive discussion on the character and pace of development would improve chances for success (Vlasin 1974).

Localities and regions that want to be effective in rural development must formulate reasonably clear policy goals and operational targets. Their formulation at local and regional levels could help address issues concerning local economic growth or limitation, locating economic activities among communities and within substate regions, locating supporting facilities and services, and developing specific guidelines for land, water, and other resource use.

Local Job Creation and Manpower Utilization

The AAEA Committee on Economic Statistics observed that among the set of concepts from the past that are clearly obsolete are those pertaining to the rural labor market constructs. We have inadequate rural labor market data built upon an outmoded conceptual base (p. 871).

Rural areas must have accurate information if their labor markets are to be more accurate and more efficient. Rural areas need such information for expansion of existing business and industry and for the attraction of new firms. Rural areas are not viewed as prime labor market areas. Their dispersed populations make survey data collection costly. Information flows are not adequate to facilitate effective response to employment opportunities that do exist—some available jobs go unfilled and for others the most qualified persons are not hired. Usually "jobs" are not advertised or "listed" locally because there is no effective local communication system (Hathaway).

What appear to be needed at local and regional levels are carefully integrated systems organized to link those concerned with aspects of rural development, job creation, and business and industrial expansion; those assessing manpower availability, both by skill and number of employees; those providing manpower training and human investment; those attempting to identify and list jobs; and the pool of potential job applicants. The glue needed to hold these parts together would be accurate, timely, and useful information.

Local Social Problems in Relation to Economic Development

Statistics on human and social conditions in rural America have been widely reported. They have helped generate increased concern about social problems and increased interest in major forms of development to help resolve them—business and industrial expansion, human resource investment, enhancement of social services, improved natural resource management and use, and upgrading of institutions (Daft).

To induce business and industry to locate in a rural community, adequate services must be provided for the firm and its employees. Adequate community services include an acceptable education system, health and medical care, recreational opportunities, acceptable energy sources and supplies, acceptable water and sewage systems, and other supporting services and amenities.

However, from the perspective of the individual local community or the regional group of communities to which it is linked functionally, we have limited insights. In what ways and over what ranges are service investments supportive of economic development? When and how are they counter to economic development or simply an income transfer? With some notable exceptions, there are few verified concepts on the role of service investments.

Regional and Other Units for Development

The unit for development is not static. The emergence of special and general purpose development districts, councils of governments, multicounty and regional agencies, community development commissions, human development commissions and economic and industrial development groups attest to this fact (Vlasin 1973). As one major example, substate planning and development units have been armed with the "review and comment" authority of OMB Circular A-95 (under the Inter-Governmental Cooperation Act of 1968). Some 500 districts have been formed and most have been staffed (Daft). Thus, the unit of development varies and is changing.

However, the observational units in our census, such as urban places, counties, and states, are fairly constant.

Edwards has observed that the unit of observation provided by the Census tend not to be the correct ones for analyzing current local development problems (p. 4). Problems at a community level frequently extend beyond city limits. Problems of a county may simultaneously be problems of a multicounty area. Problems of metropolitan centers can impact rural areas at great distances. Problems arise at a multistate geographic level as well. In short, there is need to assess the unit of observation used in reporting data against the level at which problems and opportunities occur and against the emerging units of development designed to handle them.

Management of the Resource Base for Economic Development

There are important opportunities for more systematic attention to the natural resource base as a stimulant or foundation for economic development. Some development efforts have been preoccupied with massive investments of capital in dramatically altering the natural endowments of an area. The notion has been that development means industry or urbanity. Every community needs its own high-employment, low-polluting industry. This approach frequently overlooks the basic resource character of a region. Appalachia, for example, is a region characterized both by isolated deprived human communities and by vast forest and mineral resources. Much of the forested land is already in public ownership and management. Yet relatively little attention has been given to the full range of income-generating opportunities available from those resources. Possibilities for utilizing the aesthetic character of the forests should be explored more carefully. Other examples might be cited.

Information to facilitate more effective management of natural resources for human improvement differs between public and private sectors. In the Appalachian area again, public forest managers need far better management information on the full range of potential outputs of forested land. They also need the authority to consider public choices directed more specifically at the needs of the people of the region. Information on outputs and foregone opportunities from alternative choices are essential for the public resource manager. These are information concerns that extend beyond those of the private manager.

In state after state, there is evidence of increasing concern for the use and quality of its resource base. A national policy on encouraging retention of good agricultural land is slowly, tentatively emerging. Several states have undertaken their own programs to acknowledge the long-run economic and social necessity of viable agriculture in the face of short-run pressures on their land resources.

Rural Development, Land, and Food Policy Interface

Any comprehensive review of our most recent efforts in rural development policy, land policy, and food policy would reveal opportunities for enhanced interaction and integration. A similar observation could be made in a review of environmental and energy policy. But recognizing the problem and systematically attacking it are truly different.

First, there is the matter of conceptualizing the magnitude of the problem and policy interrelations. A plea for expanding the scope of traditional economic models or a plea for use of a holistic or ecosystems framework hardly is more than a beginning (Ditwiler).

Second, there is the matter of designing an information system that somehow ties these various aspects together. If one simply reflects upon the current discussions concerning the construction of meaningful indicators for environmental quality, social well-being and quality of life, and their potential association with economic indicators, the challenge is awesome.

Probably major gains can be made first by focusing on local and regional decision makers expending funds for information in these policy areas. However the profession should not shrink from exploring complementarities among the several policy arenas at the state and national level.

Avoiding Implementation of Narrowly Conceived Information Systems

The recent literature gives little explicit recognition that we can avoid creating future information system problems by exercising more care today in what we implement. Examples from the current year help make the point more substantively.

Standard Consolidated Statistical Areas

Now being discussed, and apparently soon to be implemented, are new Standard Consolidated Statistical Areas (SCSAs) for the United States. Criteria for the designation and definition of SCSAs deal with data issues of contiguity, size, urban character, and integration. In short, the criteria would combine two Standard Metropolitan Statistical Areas (SMSAs) that are contiguous when one of the SMSAs has a population of at least 1,000,000 and when at least 75% of the population of each SMSA is urban. The criteria require various commuting rates and an acceptable title, and that's it. The criteria are devoid of problem purposes, policy choice consideration or concepts about how urban centers relate to one another and to the outlying areas to which they are linked.

One might ask, what is the conceptual basis for creating the SCSAs? Scholars in the field of regionalism have raised serious questions about the SCSAs and SMSAs. As proposed, the SCSAs are not designed to aid with any problem articulations or key policy choices or options, e.g., policies pertaining to settlement patterns, rural-urban balance, key rural-urban interactions, economic growth, economic dispersion, quality environment, or minimization of transit and transport, to name but a few possibilities. There is also the distinct possibility that once an SCSA is created, it will be institutionalized by law (e.g., tying grants and aids to it) and henceforth serve as an institution for policy and program for which it was never intended. It happened with SMSAs.

Substate Statistical Regions

The same federal committee on SCSAs also concluded that consideration should be given to offering the governor of each state the opportunity to designate a single set of Substate Statistical Areas, SSSAs. The Office of Management and Budget would recommend to federal agencies that data from existing statistical series be published for those areas. In this case, the areas would not be established on the basis of standard criteria, but on the basis of the informed judgment of the governor in each state.

Again, there is cause for serious reservation. The state of the arts in delineating functional regions and its application by state executive offices in designating substate areas leaves much to be desired. The governors are in the best position to indicate the best (current) basis for substate areas that would foster their planning and program purposes, but vastly different criteria might be used in delineating the SSSAs by the different states. Further, criteria developed by a particular state might not be applied consistently even within that state.

Thus, some logical suggestions are needed from the federal level for considerations in delineating SSSAs. Further, some plan for upgrading the definitions and delineations of these areas as new knowledge and new relationships emerge also is needed. The SSSAs must be viewed as dynamic, not static, to facilitate improvement over time. Special attention must be given to "building blocks" in the dynamics of regions.

As with SCSAs, these data units can be institutionalized by law or by historical practice and become instruments of policy. Data units are not policy neutral. We are familiar with the federal legislation and grants that are tied to numbers of farms, farmers, and farm population that tend to preserve a statistical farm profile out of touch with today's farm definitional needs, but we seem slow to learn the lesson it holds. We must give special attention to avoiding the implementation of narrowly conceived information systems.

Supplementing Current Information Systems

There are various opportunities for supplementing current information systems that are basically sound but suffer from inadequate articulation of new problems or decision choices. We cite three.

Improved Information on Resource Base Management for Development

The role of natural resources in economic development can be understood and implemented only with accurate and timely information. There are some apparent gaps.

If retention of viable farming is to be pursued as a policy, data classification schemes, definitions, and systems for organizing and distributing information are absolutely essential. Needed is accurate information on "what" and "where" are the production resources most able and likely to respond to intensified cultural practices. Also needed are consistent definitions and measurements of

land quality going beyond the useful but limited soil classification systems. We lack adequate or consistent price information on farmland or the linking of prices to qualities demanded for various purposes (Barlowe and Vlasin).

States, counties, and communities may have a major benefit from retention of their agricultural land in active agricultural production. But as data are presented and analyzed now, that possible benefit is obscure. These same governmental units have an important need also for ownership information, including parcel sizes and concentration of ownership. Such statistics can facilitate more effective public rules guiding use of land resources.

The basic strategy in this and other instances must be to articulate clearly the resource development challenge, inventory the policy options relevant to the natural resource base, and then generate information that will demonstrate the relative feasibility of those options. Information must be directed at problems; we cannot afford the funds, time, or energy to continually try matching problems to information.

Improve Measurement and Information on Public Goods and Services

In recent years, we have seen a major growth in public goods and services and in institutions that provide them. The flow of public goods and services has expanded in a variety of delivery modes, output combinations, and output quantities. Their benefit and cost characteristics and the incidence of both have been receiving increasing attention.

The challenge here is to derive measures of output that are operationally and analytically functional and that can be used in development of data bases and information systems. We need more systematic information on the quantity and quality of nonmarket goods and services and environmental amenities which contribute to an enriched quality of life. This is the basic production function in formulations we are familiar with in other contexts. We also need more systematic information on the institutional arrangements that deliver those goods, services, and amenities to the final users. Since a number of information channels now exist on public services, these could be supplemented with improved or additional measures of output, and cost and benefit characteristics.

There is a problem in consolidating information for local public officials about effective delivery of public goods and services. Thus, the synthesis, summary, and portrayal of such information in a new system for local public officials and others should be explored.

Measuring Functional Relationships within and among Regions

Earlier we indicated major growth in the number of planning and development substate regions. Also we flagged likely federal efforts to create SCSAs and foster SSSAs—both regions of a sort. If we are to make improved decisions on regional delineations today and enlightened adjustments in regions in future years, we must know a great deal more about functional linkages within and among regions.

We have been well served by contributions from this profession concerning multicounty functional economic area delineation. We know a great deal about retail, wholesale, labor, banking, and other economic linkages, and we have some examples of outstanding information series based on counties and regions. We also know about physical and ecological linkages as well as those for recreation, education, communication, health care, transportation, and other supportive social, cultural, and governmental purposes.

We have not moved to systematically measure the magnitude and strength of such functional linkages other than economic for defining substate regions. Such information could be made a part of our information series on counties and greatly facilitate governmental adjustment and sound regional growth over time.

Suggestions for New Information Systems and Approaches

Design of Systems Approach to Local Economic Development

As Edwards observed in efforts for the Task Force, local economic development is multifaceted. A positive gain in one area can result in problems, conflicts, or negative economic and social reversals in others. Rather than trying to improve single items or things at the margin, a systems approach is required (p. 2).

Accordingly, the profession needs to de-

velop very soon a more precise statement of the total problem or challenge of local economic development—a solid conceptual treatise. It needs to systematically inventory the theory available to describe the problem, the necessary data bases, and the institutional arrangements used or required. This systems approach must be sensitive to various feasibilities—physical, environmental, economic, social, cultural, administrative, and legal. Further, it must be sensitive to citizen perceptions, preferences, and priorities, and to citizen participation required for continuing local support.

The profession also has a responsibility to assist more directly with development, i.e., to help create jobs and income through a more informed decision-making process. We need to assist through improved concepts and improved information for articulating current problems, identifying plausible actions, evaluating alternatives and their likely consequences, and measuring outcomes. Such involvement will bring added reality to the design of a systems approach to local economic development.

Systematic Approach to Analysis of People's Preferences

A major commitment is required for systematically upgrading citizen or public input to the decision-making process. An approach with considerable promise is the statewide, development-oriented public opinion survey now in use or planned in several states. Given the initial successes of such surveys, it is likely that other states will undertake them. The experiences of these several states should be coordinated and analyzed for the profession.

We should develop a statement for the profession on the concepts and objectives underlying the surveys, the role of such surveys in development, the survey processes, the analyses of results undertaken, the information systems developed, and the decision modes in which the information is being used or could be used. It is even possible that with some national support, a degree of comparability among the states could emerge and that major new data bases about citizen preferences and values could be achieved. The profession may want to sponsor a working group to help explore this matter.

We also should deliberately look beyond the opinion surveys to alternative systematic means of documenting human preferences. For example, referendum approaches need to be explored. There may be other approaches that could yield a superior information result in content, quality, coverage, consistency, and additivity.

The emphasis here is on development of an efficient, effective systematic approach to determining people's preferences and bringing the resulting information to the development process. From a policy perspective, such added new information should serve to democratize the decision-making process. But we must also acknowledge that public decisions do not automatically emerge from the plethora of conflicting notions of the "good life."

New Labor Market Information Channels and Effective Manpower Services

The need for better labor market information in rural America exists at all levels—local, regional, state, and national according to Sturt, director of the Federal Rural Manpower Service. At the national level we need data that will secure equity of access to manpower services for rural workers, assist in conducting ongoing manpower programs, and aid in planning strategies to upgrade both the quality and quantity of manpower services available to rural people. This information would serve to upgrade the incomes of rural workers, expand their range of choices, and assist in improving the quality of life for themselves and their families. To further improve the data provided, some agreement is needed about what constitutes rural areas for labor purposes so that statistics can be tailored to meet the concept rather than concepts designed to meet available data.

One suggestion by Sturt is development of necessary statistics and analyses that would help project for rural areas the size of the rural labor force in the next five to ten years, with and without a net out-migration. The statistics could be used to show how many rural jobs would need to be created if government leaders want to reduce net out-migration to zero. Also needed are independently determined data, by industry, on composition and trends of nonfarm employment in nonmetropolitan areas (Sturt).

There are opportunities for a variety of experiments linking people and activities into a system for job creation, business and in-

dustrial expansion, manpower training and placement, and other manpower services and supportive human investment programs. The data requirements, analytical approaches, information flows, and organizational processes and structures could be designed, tested, and evaluated prior to widespread use.

Data on Institutional Performance

One of the common elements in the Task Force discussions and papers was the adequacy of rural institutions. For example, we could focus on the adequacy of legal institutions and tools such as land reservations, zoning, and tax incentives. Or, we could look at operating institutions for basic social services such as health maintenance organizations, regional police or fire protection units, and state planning agencies.

We need systematic ways of tracking the number, nature, and especially performance of institutional units. Performance analyses should determine the potential benefits and costs of different ways of delivering public services. They should include who benefits from the information system and who subsidizes the cost of the information inputs. Performance analyses also should encompass who decides how the institution should function or how the rules of the game are set and followed.

While there are many decentralized studies and a few national inquiries into the nature and performance of institutions for basic public services, we still lack the detailed documentation of the implications of alternative delivery mechanisms. For example, what difference does zoning make in the cost, character, or pace of community change? Or is there any difference in cost or service delivered if small governmental units contract for police services rather than do the job themselves? Only with this type of performance information can effective institutional programs be achieved. It appears that research in these matters could be done on a decentralized basis and systematic accumulation of output could be achieved.

Opportunities for Fostering and Coordinating Specific Decentralized Efforts

One of the insights surfaced by Gardner was the possibility that the inadequacies in our centralized system for social and economic statistics are best met by investments in the decentralized system of social science research. A decentralized system is flexible, a trait of major importance. It can accommodate small scale or varied scale efforts. It permits diversity of approaches and experiments. When combined with a second idea discussed by Gardner, a possible deliberate coordination and funding of the decentralized data collection effort by a federal unit, it becomes even more intriguing.

The profession could deliberately explore a bold decentralized but coordinated and funded approach to social and economic data collection and improvement for rural areas. The inquiry could encompass opportunities for decentralized data collection that would fill major data demands, operational strategies to be followed, and costs and benefits from following such strategies.

Concluding Observations

There are many immediate actions that can be taken by members of this profession to improve data bases and information systems for rural America. Suggested are three major categories of action: (*a*) avoiding hasty implementation of narrowly conceived information systems that are conceptually or operationally faulty; (*b*) supplementing current information systems that are basically sound but suffer from inadequate articulation of new problems or decision choices; (*c*) exploring, conceptualizing, developing, and testing new information systems required for dealing with various policy issues or decision choices.

We provided as well a rudimentary framework for dealing with data base and information system assessment. It encompasses the nature of problems that are confronted, the purposes to be served by data bases or information systems, and the processes by which information systems function including institutionalization.

We join others in stressing that special attention must be given by economists to information users and decision makers in developing improved conceptual bases for information systems (Daft, Bonnen). We must establish working relations with them and explore their objectives, problems, decision processes, information requirements, measures of societal improvement, and measures of program performance. Armed with such insights, the

economist can make more substantive contributions now and in the future to conceptualization and improvement of data bases and information systems.

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Productivity and Capacity of U.S. Agriculture
(Earl R. Swanson, University of Illinois, Chairman)

Concepts and Measurement of Agricultural Productivity

Laurits R. Christensen

As a general rule . . . it is better not to limit productivity indexes that purport to measure change in efficiency to a comparison of output with a single resource. The broader the coverage of resources, generally, the better is the productivity measure. The best measure is one that compares output with the combined use of all resources.

S. Fabricant (P. 6)

Along with Fabricant, U.S. agricultural economists recognized early the inadequacy of partial productivity indexes such as output per man or yield per acre. By 1947 U.S. Department of Agriculture economists were experimenting with the total factor productivity approach (Cooper, Barton, and Brodell). Based on later work by Loomis and Barton, the USDA instituted regular statistical series on total outputs, inputs, and total factor productivity. Thus, I do not believe that I have to convince this audience of the importance of the total factor productivity concept. I will limit my discussion to issues involved in implementation of the concept.

Conceptual Issues in Productivity Measurement

Index Number Procedures

The conventional approach to the measurement of total factor productivity involves the computation of an index of total output and an index of all factor inputs. Total factor productivity is then simply computed as the ratio of the output index to the input index. Virtually all practitioners adopt this overall framework. However, there is a wide disparity among methods used to implement the framework. A major area of disagreement centers on the choice of an index number procedure used to aggregate outputs and inputs. There is no formal difference between the output and input cases. For brevity I will couch most of my discussion in terms of inputs.

To my knowledge, all official index number computations made by U.S. government agencies use base period weighting schemes. This includes the USDA computations of total farm output and input, computations by the U.S. Department of Commerce for the National Income and Product Accounts, as well as the consumer price index published by the Bureau of Labor Statistics. All of these indexes are Laspeyres quantity or price indexes. The Laspeyres quantity index can be written as

$$X_1/X_0 = \Sigma p_{i0}X_{i1}/\Sigma p_{i0}X_{i0} = \Sigma w_{i0}(X_{i1}/X_{i0}),$$

where $w_{i0} = p_{i0}X_{i0}/\Sigma p_{j0}X_{j0}$, the subscript zero is the base period, and the subscript one is the comparison period. The widespread use of the Laspeyres quantity index evidently stems from its ease of use and intuitively appealing interpretation: Since prices are being held fixed at their base period levels, the Laspeyres index purports to tell us how much of the change in value of total input resulted from pure quantity changes.

In recent years several academic studies on productivity have argued that the Divisia index is preferable to the Laspeyres index. The Divisia index is defined in continuous time by the line integral

$$X(t)/X(0) = \exp\{\int(\Sigma w_i(t)(\dot{X}_i(t)/X_i(t)))\},$$

where $w_i(t) = p_i(t)X_i(t)/\Sigma p_j(t)X_j(t)$. Discrete approximations to the Divisia index converge to the Divisia index as the discrete units of

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time become small enough. So one might hope that discrete approximations to the Divisia index would inherit its nice properties. (A clear exposition of the properties of the Divisia index is contained in Hulten [1973]). However, there are many ways to approximate a Divisia index. The one used most widely in current research is the (arithmetic average) weighted log-change index

$$\log (X_1/X_0) = \Sigma \bar{w}_i \log (X_{i1}/X_{i0}),$$

where $\bar{w}_i = (w_{i1} + w_{i0})/2$. This index is one of many mentioned in passing by Fisher. It has been recommended for applications by Tornqvist and subsequently by Theil and Kloek and has been used extensively by Christensen and Jorgenson. They refer to it as the Divisia index, but to avoid confusion I refer to it here as the Tornqvist approximation to the Divisia index or simply the Tornqvist index.

There has been some confusion about properties of the Divisia index and approximations to it, as well as some disagreement on how attractive the index is for practical work.[1] In cases where critics have proposed an alternative, it has invariably been the traditional base period (Laspeyres) weighting method. However, Jorgenson and Griliches have shown that the Laspeyres index itself can be interpreted as a discrete approximation to the Divisia index. Thus, arguments about the attractiveness of the (continuous) Divisia index become irrelevant. It is necessary to compare indexes such as the Laspeyres and the Tornqvist on other grounds. Fortunately, there have been recent advances in the economic theory of index numbers, which provide important new insights into the nature of various indexing procedures including those of Laspeyres and Tornqvist.

The economic theory of index numbers can be described as rationalizing index number formulas by particular functional forms for production functions. Recent contributions to this field have been made by Afriat, Diewert, Pollak, and Samuelson and Swamy. Index number formulas have long been thought of as approximating production functions. We now have results which show that many index number formulas not only approximate but represent exactly particular production functions. The key result for our discussion is that the production functions underlying both the Laspeyres index and the Tornqvist index have been discovered. The Laspeyres index is exact for a linear production function, which specifies a priori that all factors are perfect substitutes in the production process. The Tornqvist index is exact for the homogeneous translog production function proposed by Christensen, Jorgenson, and Lau (1971, 1973).[2] The homogeneous translog production function can provide a second-order approximation to an arbitrary twice differentiable homogeneous production function. Diewert has used the term "superlative" to characterize index numbers which are exact for production functions having this approximation feature. Such production functions are often referred to as "flexible" because they can approximate production structures with arbitrary substitution possibilities.[3]

A fundamental result of the economic theory of production is that producers minimize costs of production by using all inputs in proportions such that their marginal productivities are equal to their purchase prices. The indexes we have been discussing can be interpreted as using prices or marginal productivities to weight input quantities. The basic difference between the Laspeyres and the Tornqvist (and other superlative) indexes is that the Laspeyres index holds prices fixed at their base period levels, while the Tornqvist index uses the prices from both the base period and the comparison period.

The use of fixed base period prices in the Laspeyres index can be interpreted in terms of the linear production function. If there is perfect substitutibility among factors of production, then an increase in the relative price of any one input would cause discontinuation of its use. If a perfect substitute is available at a lower price, there is no rationale for using the higher priced input. If all inputs are used in both the base period and the comparison period, it follows that the relative prices are the same in both periods. There is no need to consider the comparison period prices since they are unchanged from the base period.

The translog function does not require inputs to be perfect substitutes. If the relative

[1] It may be worth noting that in the debate between Denison and Jorgenson-Griliches on productivity measurement there was agreement on the attractiveness of the Divisia index approach.

[2] The translog function has been widely used in recent empirical studies. An example using the homogeneous translog production function is Berndt and Christensen.

[3] Diewert has shown that Fisher's ideal index is also superlative. The Fisher index is the geometric mean of the Laspeyres and Paasche indexes. The index is exact for the quadratic production function, which is flexible.

price of an input increases, the producer decreases its use (substituting other inputs) until all marginal productivities are proportional to the new prices. Hence, the prices from both periods enter the Tornqvist index to represent the marginal productivities in both periods.

I do not know of any economist who has advocated the use of linear production functions as good approximations to the real world. Nonetheless, users of Laspeyres indexes are implicitly taking that position. Use of the Laspeyres index could perhaps be defended on the grounds that changes in relative prices are likely to be small over short periods of time. If the amount of time between the base period and the comparison period is short, the difference between the Laspeyres index and the Tornqvist index is likely to be quite small. In practice, however, it is very tempting to use the same base period to construct index numbers for comparison periods which become ever more distant from the base period. For example, the USDA Handbook on its major statistical series indicated that 1947–49 was used as the base period in constructing the index of total farm input for 1940 and all later years.[4] When the time between the base period and the comparison period is not short, substantial price change may occur. In fact there have been large changes in the relative prices of farming inputs in the postwar period. Thus, the actual time path of aggregate farm input may be substantially misrepresented by the USDA index. This would imply corresponding errors in the USDA series on total factor productivity.

The Value-Added versus the Gross Output Approach

Since much of the early empirical work on productivity was done at the economy-wide level, it was natural to work with GNP (or something closely related), which is value-added summed over all industries. Not surprisingly, researchers then applied the same treatment on an industry-by-industry level. Kendrick's work is the archetype of this approach, which considers the productivity of capital and labor (value-added) to the exclusion of purchased (intermediate) inputs.

In recent years the exclusion of intermediate inputs in productivity studies and production function estimation has come under increasing attack. At the 1965 National Bureau of Economic Research Conference on the Theory and Empirical Analysis of Production, Domar noted that most of the authors made no mention of intermediate inputs in their papers. He underscored his point by remarking: "It seems to me that a production function is supposed to explain a productive process, such as the making of potato chips from potatoes (and other ingredients), labor, and capital. It must take some ingenuity to make potato chips without potatoes" (p. 471). Arrow has recently pointed out that the existence of a value-added function requires that intermediate inputs be separable from primary inputs; this places severe restrictions on marginal rates of substitution which are not likely to be realistic. And Hulten (1974) has argued that even if the value-added function exists, the exclusion of intermediate inputs assigns all measured technical progress to capital and labor input, ruling out increased efficiency in the use of purchased inputs.

The number of papers in the literature recognizing intermediate inputs is small, but it is bound to grow rapidly in coming years. As the relationship between aggregate productivity change and industry-by-industry change becomes clarified, the value-added approach is likely to go out of fashion. The more general approach will require more data, but this should not be an insurmountable barrier. Because of the USDA's foresight, the data for the farm sector are already available. When the USDA established its data base, it recognized the difficulty of "producing potato chips without potatoes." It evidently reasoned further that it is even more difficult to produce potatoes without seed, water, and fertilizer. Thus, all purchased inputs are included in the data base, and the total factor productivity estimates are for gross output of the farm sector, rather than valued-added. This is especially important for the farm sector because of the changes which have taken place in the food production process. It used to be a reasonable approximation to say that farmers sold to consumers food which had been produced from capital, labor, and land. Over the years, however, farmers have purchased more and more inputs. In addition, the farmer's output has undergone more and more processing before being delivered to consumers. A good understanding of the whole agribusiness sector will require modelling which recognizes

[4] I have been informed that 1957–59 is currently being used as the base period.

the importance of purchased inputs in the farm sector as well as the output of the farm sector as purchased input to the food-processing sector. The value-added approach, which ignores these purchased inputs, is not likely to be satisfactory.

Other Issues

We have seen that the economic theory of index numbers allows us to relate index numbers to the theory of production. Thus, the production structure underlying the index number approach can be illuminated. Above we have concentrated on the functional form issue, but there are other attributes of the implied production structure which deserve scrutiny.

The index numbers I have discussed are clearly appropriate when the structure of production is homogeneous of degree one. If the actual structure of production is not homogeneous but still homothetic, no harm is done.[5] Measured changes in total factor productivity are valid, but part of the change may be attributable to scale economies or diseconomies rather than to technical change. Further research on scale economies can lead to a disentangling of the sources of change in measured total factor productivity. Even if the structure of production is nonhomothetic, economic theory provides some appealing justification for the use of flexible index numbers. In the homothetic case, all isoquants have the same shape. Therefore, the distance between any pair of isoquants is the same on any ray from the origin; and bundles of inputs can be compared directly. However, in the nonhomothetic case, isoquants can have different shapes. Comparison of input bundles can be made only by reference to an isoquant corresponding to a particular output level. Diewert has shown that the Tornqvist index is exact for the nonhomothetic translog function when the isoquant for the geometric mean output (of the base and comparison period input bundles) is the basis for comparison. In the context of consumer price indexes, Christensen and Manser have provided some empirical evidence that a time-series of Tornqvist indexes can approximate a nonhomothetic preference structure quite well. They estimated a nonhomothetic translog utility function and found that the implied cost of living index was closely approximated by the Tornqvist price index. Departures from homotheticity in the structure of production are likely to be less important than in the structure of consumer preferences. Therefore, the Tornqvist quantity index can probably be safely used in analyzing most production situations.

Hulten (1975) has recently argued that the conventional approach to total factor productivity does not allow for the dynamic interaction between technical progress and capital accumulation. Technical progress leads to additional output, part of which results in a larger capital stock. In this view, future output which can be attributed to capital accumulation induced by technical progress should not be labelled as resulting from increased input. Such an attribution tends to understate the importance of technical progress in the growth process. Hulten concludes that the conventional measure of total factor productivity is correct for measuring changes in productive efficiency, but the results should not be interpreted as allocating economic growth between technical progress and real factor inputs, as is often done.

A related objection is that the conventional approach assumes all technical progress to be neutral, independent of the time trends of the factor inputs and their prices. This is not consistent with beliefs that technical progress is embodied in capital, or labor, or some particular purchased input, or induced by changes in relative prices. Theorists have conjectured a host of nonneutral forms of technical progress. This is an area which requires sophisticated econometric research to sort out the importance of various possibilities. Some interesting work in this direction has recently been reported by Binswanger. Using the translog cost function, he found that technical progress in U.S. agriculture has been strongly fertilizer- and machinery-using and labor-saving. The relative proportions of these factors in the production process have changed considerably more than can be explained by the changes in their relative prices. Further research is needed to assess the implied errors in conventional measures of total factor productivity in U.S. agriculture.

The conventional method for measuring total factor productivity proceeds with the independent estimation of an output index and

[5] A function is homothetic if it can be written as a monotonic function of a linearly homogeneous function.

an input index. An implication of this procedure is that the underlying production structure is separable, i.e., that the marginal rates of substitution of factor inputs are independent of the levels of the various outputs. It is easy to think of examples where such a specification is not very plausible. Agricultural production is often divided into the two broad categories of crops and livestock. The assumption of separability implies that differing ratios of crop and livestock production will not entail any difference in efficient levels of land, labor, capital, or intermediate inputs. Diewert has proposed a new method for measuring productivity which would relax the separability assumption. His method involves index numbers representing a transformation function, rather than separate input and output functions. Diewert points out that there are disadvantages as well as advantages to his method. However, empirical experimentation with his method is certainly warranted.

Measurement in the U.S. Farm Sector

To my knowledge the USDA is the only U.S. government agency which computes a total factor productivity index on a regular basis. Although total factor productivity has been a respectable scientific concept for nearly three decades, the U.S. Bureau of Labor Statistics still publishes nothing but labor productivity estimates as its "official" productivity indexes. The USDA is to be commended for leading the way. Perhaps they can convince other agencies to expand their input coverage. Even if one believes that a particular partial approach provides the most interesting index, total factor productivity indexes are essential for understanding variations in the partial index.

One of the most serious problems with the USDA total factor productivity index is the use of Laspeyres indexes for total output and total input. In light of our new knowledge on the economic theory of index numbers, it is difficult to justify the continued use of the Laspeyres index. It is even more difficult to justify keeping the base period for the Laspeyres index fixed for long periods of time. The National Academy of Sciences has also criticized the USDA index procedures. Their recommendation was that the base period for the Laspeyres indexes "should be changed more frequently, at least every five years" (p. 32). While this would be a move in the right direction, I believe that a more fundamental change is in order. The USDA should institute a superlative index number procedure which can closely approximate the underlying production process. Fisher's ideal index and the Tornqvist index discussed above are leading candidates. If there is any disadvantage to such indexes, it is that they require prices as well as quantities for all years. However, my impression is that this would not present any major problems. The data requirements are no more severe than for the Laspeyres index with an annual change of base period—the logical conclusion of the NAS recommendation of frequent changes.

Over the years various authors have pointed out that the USDA input index neglects important quality changes which have been taking place. For example, Griliches pointed out that increasing quality of farm labor, machinery, and fertilizer were not reflected in the USDA index. The result is that the growth of total input is understated and the growth of total factor productivity has been overstated. Unfortunately, the criticism is as valid today as it was in 1963. Rather than responding with improvements in procedures, the USDA has been content to acknowledge: "The input index does not adequately measure changes in quality of inputs over time. The failure of the series to measure quality change is an inherent problem in most indexes" (p. 8). Star has recently emphasized that "quality change" is simply another name for "errors of aggregation." The solution to the quality change problem is the same as the solution to the index number problem. Errors of aggregation occur because there are changes in the mix of the components making up the aggregate. Use of a superlative index number procedure on the components will correctly capture the quality change which is occurring. Star's empirical results for U.S. manufacturing demonstrate that the use of the Laspeyres index to aggregate components of capital and labor can lead to substantial errors.

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Inventory and Critique of Productivity Estimates in the U.S. Food and Fiber Sector

Eric C. Howe and Charles R. Handy

A major responsibility of the Economic Research Service has been to monitor and evaluate the performance of the segments of the U.S. food and fiber system. Due to increasing interdependence among the various segments of the sector, the agricultural economics profession is giving greater emphasis to developing consistent economic accounts and performance measures across the entire food and fiber sector. The purpose of this paper is to explore alternative methods for developing a total factor productivity measurement system for the food and fiber sector. Such a measure would allow us to monitor changes in the efficiency with which the sector utilizes inputs in producing food and fiber for final demand.

Defining the Sector

Lack of an operational definition of the food and fiber sector has hindered the development of sector performance measures. The profession seems to be converging on a general conceptual definition of the sector as including the farm inputs subsector, the agriculture subsector, and the product market subsector which includes processing, wholesaling, and retailing (USDA; Upchurch; Carlin and Handy; Walters). While this definition helps to identify the broad parameters of the sector, it has not been a particularly useful guide for empirical studies which must determine which establishments, industries, or parts of industries are included in the sector. The easiest method would be to define certain industries on the basis of direct sales to or purchases from agriculture, for example, the work underway by an ERS task force headed by Conrad Fritsch. However, this approach ignores indirect effects which can be pronounced. For example, agriculture does not purchase products directly from either the crude petroleum and natural gas or the primary iron- and steel-manufacturing industries. However, a $1 increase in final demand for agriculture causes an increase in demand of 2¢ for the former and 1¢ for the latter (USDA). Certainly a sector definition which is to be used for productivity analysis is suspect if it implies that these two industries are entirely outside of the food and fiber system merely because agriculture does not purchase from them directly. No single definition of the sector will be suitable for all research and policy objectives. (In fact, a realistic definition must change over time.) Nevertheless, a comprehensive definition using consistent descriptors and data sources would allow individual researchers to develop different configurations of industries to meet individual research needs.

The remainder of the paper will survey existing productivity measures and assess their potential use in developing a total factor productivity series for the food and fiber sector. We then evaluate and compare two alternative methods for constructing such a productivity series. Finally, we suggest which methodology, at this stage, seems most promising for achieving our objective.

Applicability of Existing Measures

To what extent can existing empirical studies be aggregated to construct a sectoral productivity measure? Studies by Gossling and Dovring are particularly relevant as guides for developing sector productivity measures (Gossling 1964, 1972; Gossling and Dovring; Dov-

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ring). Since Gossling defines the final output of his "gross output subsystem" at the farmgate, only agriculture and all direct and indirect inputs required to supply agriculture are included in the subsystem. A more detailed discussion of Gossling's input-output approach will follow below. Gossling and Dovring use the "gross-output subsystem" approach to measure aggregated labor productivity in U.S. agriculture. Farm output for final demand is divided by the sum of all labor used directly on farms as well as labor used indirectly to produce purchased farm inputs (both durable and nondurable). This methodology provides a much more comprehensive measure of total inputs than conventional productivity studies, but it needs to be extended beyond the farmgate. Most existing measures of productivity are, like the Gossling and Dovring indexes, partial productivity measures in that they relate output to only one input—labor. Partial productivity measures are useful in showing any savings in the use of a particular input over time, but because of factor substitutions, these measures do not reflect changes in the net efficiency of all inputs used.

Input-output tables were also used in a 1966 study by Gale to compute the total output, labor and value-added requirements, and labor productivity for the entire "food subsystem." Expanding Gossling's methodology, Gale defined the food subsystem as all direct and indirect requirements of farming, food manufacturing, food distribution, and transportation industries needed to produce the output represented by civilian expenditures for farm food. In essence, Gale uses the I-O inverse transaction matrix, $(I-A)^{-1}$. A major shortcoming of Gale's productivity measure is that it includes only current production requirements omitting capital requirements. Beyond these studies, there are several productivity measures for individual industries in the food and fiber sector. A selected inventory of such measures, starting with farm inputs and proceeding through distribution follows.

Though no productivity series exists for individual farm input industries, ERS is developing total factor productivity measures for the farm machinery and agricultural chemical industries. The series, which will extend from 1947 on, computes productivity as the ratio of real value added over a linear aggregation of real labor and capital inputs.

Most productivity studies in the food and fiber sector focus on the farm subsector. They include series on net output per person (U.S. Dep. of Labor) and total factor productivity series based on gross output over total inputs (Loomis and Barton) and on net output or value-added over total input (Kendrick 1961, p. 363, 1973, p. 78). A review of agriculture productivity measures and concepts is provided by Horring. Besides aggregate farm output, productivity measures are also available for individual commodities. In particular, Dovring has computed productivity indexes for twelve separate commodities (Dovring, pp. 24–58).

Several studies compute productivity series for various industries within the food- and fiber-processing subsector. Kendrick computes total factor productivity from 1948 to 1966 for food and kindred products and textile manufacturing. ERS also is developing total factor productivity measures for each of nine three-digit industries within Food and Kindred Products (Standard Industrial Code 20). Remaining studies in the food-processing subsector restrict analysis to measures of labor productivity. These include series computed by the Bureau of Labor Statistics (index of output per man-hour for seven food processing industries), ERS (output of farm-originated foods per man-hour for eight food-processing industries), and Waldorf and Gale's study of value-added per man-hour in factories processing farm food products.

Due to conceptual and data problems in measuring output and associated inputs for the distribution subsector, only a few studies attempt to measure productivity in food distribution. The most comprehensive study computes net output (value-added) per man-hour in distributing farm-food products (Waldorf and Gale, and updated in Gale and Van Horn). In a 1969 study of real dollar sales per man-hour in retail trade, Schwartzman constructs separate productivity series for eight store types including food stores and eating and drinking places. Finally the BLS is developing an annual labor productivity series for food retailing based on the combined gross output per man-hour of grocery stores and specialty food stores. However, this series, as yet, has not been published.

This sampling of the literature reveals that a large number of individual productivity measures are available for many of the individual segments of the food and fiber sector. Conceptually, individual works might be aggre-

gated industry by industry to develop a sector productivity series. Unfortunately, available measures follow no consistent methodology for measuring outputs or inputs and thus, even if a satisfactory weighting system was found for combining existing industry productivity series, lack of consistency makes any aggregation impracticable.

The Ideal Measure

What do we want in a productivity measure? In evaluating the food and fiber system, ERS is concerned with both economic as well as technological productivity. Productivity can be approached from the very broad perspective of economic efficiency, from the narrower and more traditional perspective of technical efficiency, or from the still more narrow perspective of technological change. In addition to the mechanical transformation of factors and materials into intermediate and final products, economic productivity includes utility. How efficiently are inputs into the food and fiber sector transformed into products and services, and how efficiently does this product and service mix yield consumer satisfaction? As a measure of economic efficiency, ERS has developed an Index of Consumer Satisfaction which will be updated periodically (Handy and Pfaff). When this index becomes available for a longer time series (now one year only), it may be interesting to relate it to sector inputs.

The conventional concept of productivity refers to physical productivity or technical efficiency defined as the ratio of real output to real input (Kendrick 1961, p. 6; Dovring, p. 8). On the other hand, productivity as a measure of technological change refers to the ratio of real output with current technology to what real output would have been with a base period technology (Solow). These two concepts are easily distinguished by considering a growing economy characterized by increasing returns to scale but no technological progress. The latter measure would show a zero advance in productivity whereas the former would show an increase. Traditionally, agricultural studies have used the physical productivity concept (Horring, pp. 30–40). That approach may be superior if you take the view that agriculture has been in a chronic disequilibrium state since the measures of technological change must rely on the annual correspondence between factor shares and the elasticity of output with respect to that factor. Still, it seems best to follow whichever methodology is most practicable and bear in mind its limitations.

Though we see the measure of sectoral productivity as important, this does not imply that measurement of productivity by industry and commodity is not. Ideally a productivity measurement system is needed which will yield both the sectoral measure and consistent industry and commodity measures. It seems unlikely that a measure is possible which will yield disaggregation by commodity since, in the process of marketing, commodities often lose their statistical and physical identities. Beyond the distinction between the above three basic approaches to productivity measurement, we need to very carefully distinguish between two different concepts of industry productivity: we are interested in measuring both productivity advance within an industry and the impact of productivity advance on an industry. Thus, an industry which produces an increasing quantity of output from a given mix of primary inputs (labor, land, minerals, etc.) and intermediate inputs (machines, structures, etc.) will show productivity advance within itself. But if intermediate inputs are being produced more efficiently elsewhere in the economy, then the measure of productivity advance on the industry will be greater. To measure productivity change within an industry, the industry's output should be related to its use of primary and intermediate inputs. To measure the impact of productivity change on an industry, one should relate the industry's output to all of the primary input used (anywhere within the economy) to produce that output.

Implementing the Ideal

We conceive of there being two basic ways to measure sectoral productivity. The most obvious is to use one of the neoclassical methodologies to measure productivity separately for each of the industries within the sector and to combine these measures with a weighted average. A number of problems with existing neoclassical methodologies will be discussed below, but the principal problem is the interindustry weighting of separate productivity series. In neoclassical works where such weighting schemes are used, an industry

is either entirely within or outside a sector. Yet only certain of an industry's activities may fall within the food and fiber sector (food wholesaling in wholesaling) and in many cases only some proportion of some activities (fiber processing is in the sector to the extent that the sector buys processed fiber and to the extent that fiber processing buys natural fiber).

It is possible to avoid the weighting problem by using the input-output approach to productivity. The I-O methodology should start with an $n \times n$ matrix of product flows, an n-dimensional vector of final demands, an n-dimensional vectors of all primary good requirements. The food and fiber sector is defined by asking how much agriculture would have to purchase of each of the other industries in order to be fully vertically integrated (see Gale, pp. 132–33.)[1] Basically, the total requirements matrix is used to "track down" all of the primary inputs used in producing sector output. Growth in productivity for the food and fiber sector can then be computed in any of several ways, all relating output to primary input. Furthermore, the above data provide all that is needed for separate measures of productivity for each I-O industry (U.S. Dep. of Commerce).

Several limitations to this approach need to be noted. Seemingly the most severe limitation is one of data. Except for labor, there is little data on primary input by industry. Gossling (1972) and Gale handled this problem by assuming that labor was the only primary good. A further data problem is that productivity can only be computed for the seven years in which comparable I-O tables exist. With labor as the only primary input, this latter problem is probably not as significant as it might seem. It is shown (Gossling 1972, p. 72) that a shortcut method proposed by Dovring yields a good approximation in non-I-O years. A final data complication is the requirement of data measuring capital stock by I-O industry.

Several limitations to the credibility of the I-O approach are implied by the necessary assumptions. To use I-O, each industry must be assumed to produce a homogeneous output which sells at a unique price. This assumes away the fact that each I-O industry produces nonhomogeneous output which is sold in varying mixes to different buyers. A further source of error lies in the assumption that each industry is in a stationary self-replacing state. This latter assumption permits the summation of the current flow matrix and the capital flow matrix to calculate "total flow" and thus completely measure industry interdependence. The notion of measuring productivity with I-O is not new, but it is not well known, so it is worth noting that the best explanation of this concept was done by Rymes in an article which should become a classic.

We now consider the possibility of measuring productivity industry by industry and aggregating to a measure for the food and fiber sector. Whereas the sector definition was implicit to the I-O approach, it becomes again an open question for industry-by-industry aggregation—one for which there is no existing answer.

Beyond the question of sector definition remains the question of how to choose weights for the interindustry aggregation of productivity indexes. Unfortunately, no recognized answer exists to this question either. There is, however, a lucid new treatment of this question in the form of a preliminary report by Hulten (1974). He handles weighting in the context of going from industry measures of productivity to an economy measure. Thus, he does not provide an immediate answer to our question, but his work does establish a theoretical basis for approaching the question—one which is destined to receive much further attention, so we shall consider it.

Hulten's main point comes from distinguishing technical change originating in an industry (measured by R_i) from technical change impacting on an industry (Z_i). His formula for measuring R_i is conventional except that it allows for intermediate input. His formula for measuring Z_i is very unconventional, namely

$$Z_i = Y^*_i - \sum_{j=1}^{M} s_j J^*_j,$$

where Y_i is delivery to final demand from industry i; J_j is the total input of primary good J used in all industries; s_j is the share of the primary input in national income; and asterisks denote rates of growth. He develops a set of sufficient assumptions for R_i and Z_i to be correct. He then shows that the rate of shift in the social net production possibilities frontier (T^*_t) can be measured from weighted sum of either the R_i or Z_i.

[1] Gossling analyzes the related question of how much agriculture would have to purchase of each of the other industries in order to be fully integrated on the input side (1972, pp. 15–29, 165–79). Conceptually there is little trouble extending Gossling's method to arrive at Gale's.

Note that Z_t would be very easy to use for our purposes. It involves only data on deliveries to final demand from each industry plus one Divisia indexed measure of primary inputs for the entire economy. More significantly, note that the formula for Z_t could be applied to easily compute productivity for the food and fiber sector merely by defining Y_t as sector delivery to final demand! Unfortunately, Hulten makes two crucial and very restrictive assumptions which cast doubt on the usefulness of this approach. Essentially, his formula only works if demand is very well behaved so that supply effects dominate in economic change. Thus, Hulten assumes that the economy is closed to international trade, that demand functions are constant over the period of analysis, and that each good has a unitary income elasticity of demand. It needs to be noted that agricultural exports are an extremely important, occasionally volatile, facet of demand, that an important element of technological change is the creation of new products so that demand functions cannot be constant, and that the income elasticity of demand for food is generally conceded to be less than one. These factors militate against the use of Hulten's Z_t and thus we are left with the use of R_t which is correct even without the restrictive assumptions noted above. There are, of course, some difficulties with the use of R_t. Except for I-O years, not enough data exist on specific intermediate inputs to measure R_t very well. Further, Hulten's interindustry weighting system needs to be extended, as discussed above.

Having raised the issue of industry by industry weighting, there are other topics remaining to be considered. Whether capital is treated as a primary good or an intermediate good, its treatment is quite unsatisfactory. In agriculture, a large portion of the fixed capital stock goes unmeasured—own account capital. An ERS study indicates that, in 1973, \$5.5 billion in capital formation is unidentified and \$2.6 billion is unrecorded for cattle alone (Dyer). Important own account items are orchards, livestock, and stands of various perennials (hay and alfalfa). Until measures of these capital items are available, all measures of agricultural productivity must be viewed with suspicion.

The traditional measurement of fixed capital is objectionable. It relies on the identity that the current period capital stock is the previous period stock minus depreciation plus investment. Clearly, the item of greatest ambiguity is depreciation. The most common measure of depreciation assumes that it is some constant proportion of the previous period capital stock. This assumption has been the subject of recent attack on the basis of empirical studies of investment and profit (Coen, Mendelowitz). Clearly, the method may be attacked on the grounds that it fails to make depreciation dependent on the distribution of investment among goods of various service lives.[2] Another common measure of depreciation, called double-declining balance, assumes that depreciation is at a rate of $\frac{2}{n}$ for a capital good with a service life of n. This method most commonly is assumed to measure the discounted stream of returns to capital. However, it is easy to show that double-declining balance depreciation implicitly assumes very unrealistic time patterns of returns to capital. For example, if the income stream is discounted at a continuous rate of 10%, then double-declining balance depreciation implies that an entrepreneur purchasing a capital asset with a service life of ten years expects a declining stream of returns over the life of the asset, whereas he expects a constant stream for a twenty-one-year asset and a continuously increasing stream for any asset with a service life of over twenty-one years. This feature of declining balance depreciation is indefensible! Rather than assume a particular pattern for the present value of the stream of profits, it seems safer to simply assume a pattern to the stream of profits. ERS has implemented this latter type of analysis and applied it to capital formation in the food and kindred products industry (Howe, Handy, and Traub).

Summary

Based on the above considerations, we can reach some conclusions as to the optimal approach for measuring productivity for the food and fiber system and its components. At this time the I-O approach seemingly has the most to offer for establishing both benchmark mea-

[2] Jorgenson and Griliches have defended this practice by asserting, with neither citation nor proof, that the distribution of replacements approaches a constant fraction of the capital stock for any "survival curve" and for any initial age distribution of capital (p. 225). Since investment fluctuates with substantial random and nonrandom components, it seems unlikely that this assertion is true.

sures of productivity and benchmark definitions of the food and fiber sector. As noted, the use of I-O does involve some strong assumptions. However, the validity of any methodology will depend on a definition of the food and fiber sector, and we can conceive of no sector definition which is valid for productivity purposes and which does not use I-O. Hence, any methodology will rely on I-O assumptions.

Hulten's aggregation theorem (on aggregating R_t's) should be extended to handle the problems discussed above and used to interpolate between I-O years.

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Inventory and Critique of Estimates of U.S. Agricultural Capacity

Heinz Spielmann and Eldon E. Weeks

The objectives of this paper are threefold: to assess where we are in research to measure agriculture's capacity to produce and prevailing levels of capacity utilization rates; to observe some possible roadblocks and methodological issues relating to the estimation of agricultural capacity and its utilization, assuming that such estimates should be consistent with those for other economic sectors and compatible with estimates of productivity and efficiency; and to suggest avenues that might lead toward estimates of agricultural capacity and its utilization.

Why Measure Capacity?

For a number of nonfarm industries, interest in capacity measurement arose from the recognition that it is an important factor in various economic analyses. It is now indispensable in diagnosing the economic situation as a whole. It is widely used in projections of future capital requirements, of anticipated expenditures on plant and equipment, and of future cost, price, and profit conditions. It is an important variable in market studies and is most prominently used in the assessment of existing or proposed private or public economic policies.

The estimation of similar measures in the farm sector would provide a vehicle for direct observation of the size, growth, and utilization of the industry for private and public purposes; provide assistance in assessing the performance of the industry with respect to general economic goals of growth, stability, equity, and efficiency; permit the analysis and early detection of imbalance among trading industries in multi-industry commodity flow systems; permit analytical placement of measures of output in a perspective to allow refinements in productivity and efficiency measures for the industry and analysis of investment behavior; and permit analysis of the trade-offs between developing new capacity and using existing capacity more intensively.

Capacity Measures

Before we discuss the various capacity measures used in the industrial and agricultural sector, let us list them and take note of the general definition of capacity: the McGraw-Hill Capacity Utilization Index, the BEA (Bureau of Economic Analysis, U.S. Department of Commerce) Manufacturing Capacity Utilization Index, the Federal Reserve Board Index of Capacity Utilization, the Wharton Capacity Utilization Index, and other systems.

In the literature reviewed, we found no work which specifically addressed itself to the construction of time series indicative of current capacity utilization levels for agriculture. Instead, the major concern seems to have centered around the determination of "excess" capacity (Quance and Tweeten, Tyner and Tweeten). More often than not, that concept is related to notions of low equilibrium market prices, low factor returns, and/or factor misallocation or adjustment problems.

Others have addressed or are addressing the question "Will American farmers be able to meet anticipated food and fiber requirements?" (Brandow; Cochrane; Culver and Chai; Heady, Mayer, and Madsen).

The disparity in the status of capacity measurement in the industrial sector vis-à-vis the agricultural sector appears to reflect the lack of a similar clear definition in the latter. Perhaps this is due to the fact that the great policy issues of the past three or four decades have involved surplus production and, therefore, low returns to farmers.

While there exist various interpretations of the term "capacity" in the nonagricultural

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sector the basic concept seems to have attained a general consensus. Two basic classifications may be discerned, namely the engineering term and the economic term.

In engineering terms, capacity may be defined as the maximum sustainable level of output of a firm that can be produced in the short run if the demand for its products is not a constraining factor when the firm is operating its existing stock of capital at its customary intensity (Klein and Summers, p. 2). A somewhat simpler definition would be that capacity is the maximum output that can be produced with existing fixed factors at normal (i.e., usual) production intensity. This definition does not reflect costs of operation, profits, or operational optimization.

The economic term, however, pegs capacity at a point of output where the average short-run function of a firm is at its minimum (Norton, p. 92). The minimum point is chosen because the upswing of the cost curve is indicative of increasingly less efficient use of the fixed factors.

Still another definition of capacity is based on a constant fixed factor-output relationship. It is exactly that output where no change in fixed factor holdings is either desired or required. In other words, it is that output which occurs at a level just before a change in the plant occurs . . . or a point at which the short run ends (Phillips).

Capacity, then, is an output measure and a short-run concept. In economic terms it is output at minimum per unit cost levels and it is independent of demand. Capacity analysis centers primarily on the individual firm. Aggregation toward industry and sector levels may be accomplished through the use of appropriate weights (e.g., value-added measures).

Two additional terms frequently used in the literature of the industrial sector may be inserted at this point. One is the capacity utilization rate (also operating rate) which is the ratio of total actual production to capacity. There is also a preferred utilization rate at which a firm optimizes its operation. Research in the nonagricultural sector shows incidentally that most industrial firms operate below that level of capacity utilization (Hertzberg, Jacobs, and Trevathan, pp. 50–51).

In the agricultural sector, a definition of capacity can only be inferred from an understanding of excess or undercapacity as used by various research workers. It appears that capacity levels in excess of commercial demand at socially acceptable prices are regarded as excess capacity and capacity levels below that demand as insufficient capacity. This leaves us with the implication that capacity is represented in the agricultural sector by some kind of equilibrium position of market demand and supply equality (Quance and Tweeten, p. 57).

Approaches to Capacity Measurement

The McGraw-Hill, BEA, and Federal Reserve Board systems depend heavily on primary data collected principally for capacity utilization measurement. The Wharton measure uses output data derived from the Federal Reserve Board Industrial Production Index of thirty manufacturing industries and from association and trade publications and some Census data for six other industries.

McGraw-Hill's surveys, which are normally conducted in the spring of each year, serve as a basis for a number of indexes such as the annual capacity utilization rate (December of the previous year) index, the prorated capacity utilization for the current year and an index of changes in capacity (1967 = 100) during the current year. This agency also obtained information on preferred capacity utilization rates in 1973 from which it was estimated that the operating rate in December 1972 was 85% while the effective rate (ratio of preferred to actual operating rate) was 93% (Gang).

For the BEA Manufacturing Capacity Utilization Index a panel of firms (2,400 companies accounting for 75% of gross depreciable assets held by manufacturers in 1969) is requested to respond to a questionnaire containing elements regarding their operating rates and preferred operating rates. This survey is conducted on a quarterly basis. Participating firms are grouped into durable and nondurable goods manufacturers and are placed into three asset size classes. The survey itself is part of a larger continuing BEA program which provides indexes of actual and expected plant and equipment expenditures as well as information on manufacturer's carryover and new investment projects (Herzberg, Jacobs, and Trevathan).

Construction of the Federal Reserve Board Index of Capacity Utilization involves use of both the McGraw-Hill Capacity Index and the McGraw-Hill Capacity Utilization Index as

well as the Federal Reserve Board Industrial Production Index and a perpetual inventory measure of gross capital stocks. Series are constructed for manufacturing and major materials. This agency develops a capacity measure which is adjusted by time-series analysis in which directional biases are mutually corrected (De Leeuw, p. 128).

The Wharton School Capacity Utilization Index, however, uses only secondary data (the FRB Industrial Production Index) and depends largely on theoretically based inferences for its implementation. This system is called the "trend-through-peaks" method and consists simply of plotting on large graphs the output of a number of industries (including about thirty elements of the FRB Industrial Production Index) in quarterly increments. Peak quarters are marked (a peak quarter is one whose values exceed those of the immediately preceding and following quarters) and are then connected by straight lines. It is assumed that peaks and the straight lines connecting them represent 100% capacity utilization rates. The distance between the straight line and the production level for each quarter is the reciprocal of the capacity utilization rate. Capacity and operating rates can then be easily calculated.

This procedure is followed for each industry separately. The graphs of all industries in the sample are then combined and aggregated into the industrial sector (Klein and Summers, pp. 1–4). While the Wharton Index is one of the easiest to construct, a number of biases seem to have entered the system in recent times which have caused its results to deviate strongly from indexes using the survey method (Perry).

Other indexes, particularly those of the Industrial Conference Board and of *Fortune* magazine, depend on an assumption of a constant fixed factor-output relationship. Here balance sheet data of participating firms in a sample are used to establish a perpetual fixed factor inventory to facilitate index construction (U.S. Senate, p. 9–10). The complexities, particularly with respect to the perpetual inventory method and shortcomings of these systems, are such that only rather limited use can be made of them. Still other systems using production functions (Klein and Preston) and rather complex variations of assumptions regarding the fixed factor-output relationship (Hickman) have not produced any of the workable capacity utilization rate indexes as described previously.

In the agricultural sector, most of the studies relating to capacity were principally concerned with examining market equilibria in relation to "excess capacity." Most of such studies utilized econometric, linear programming, or simulation models to study market prices and quantities, factor returns, and resource allocation efficiency. Thus, the concept of excess capacity was made directly and at least partially dependent on demand.

One methodology used to address the question, "Will American farmers be able to meet anticipated food and fiber requirements?," is examination of a group of extrapolations. These researchers compared projections of per capita demand with those of yields and production.

Since these methods did not result in current capacity and capacity utilization measures (indexes or series) we searched for alternatives. These included consideration of the use of aggregate production functions and supply functions to estimate capacity indicators, the adoption of some of the methods employed in the nonfarm sector, and finally the use of production possibility functions.

Before we can offer a critical evaluation of the approaches discussed in this section, we will consider some of the characteristics of the agricultural sector which may present special complications in the development of a capacity index.

Special Characteristics of the Farm Sector for Capacity Measurement

Whatever the reasons for the lack of attention paid to measurement of agricultural capacity and its related indexes on an ongoing basis, we believe that such an effort may be feasible. Nevertheless, we think some characteristics of the farming sector are not common throughout the economy and should be considered specifically in successful designs for capacity measurement in agriculture. The purpose of this section is to identify a selected few of these characteristics.

To a degree perhaps unmatched in any other major materials-producing or manufacturing industry, farmers can substitute products for each other, given the same set of fixed factors. Thus, the appropriate degree of aggregation or dissaggregation is an important methodological judgment. And the aggregation question is further complicated by the large number of characteristically different kinds of farm fixed

factor sets contained within a relatively large population of producing units.

Output rates from one production period to another can be profoundly affected by weather variations. The identification and treatment of these effects are serious issues for farm sector size and input efficiency measurement.

Three broad classes of fixed factor stocks on farms which could conceivably limit capacity may be considered. One is represented by machinery, equipment, and structures. Another is represented by land. And a third is represented by breeding herds and flocks, trees, and vines, bushes, and other perennial plantations. This third class of fixed factors is entirely produced, reproduced, and utilized within the sector. Its magnitude can be very quickly diminished, but its expansion rate is considerably affected by well-known biological life cycles.

Job contracting involving the use of equipment and implement leasing are certainly not unique to agriculture. But there is evidence to indicate that recent trends in the structural change in farming include increased substitution of job hire and equipment leasing for the services of owned equipment and own-account operations. Conventional wisdom would point one toward certain service and trade industries for the existence and utilization of capital stocks whose services are employed in agriculture.

Again, this is a feature that is not unique to agriculture even though it implies very complex and important considerations for constructing measures of industry size and efficiency. One may be hard pressed to name an industry that has more facets more profoundly anointed or afflicted, depending upon one's viewpoint, by public policy. Of direct and particular interest for the measurement of capacity and its utilization are those programs through which industry-wide capacity growth and utilization decisions are shared by the public and private sectors. These should be very carefully considered in the construction of capacity measurement methodology, especially if postmeasurement explanations of change are desired.

A very significant number of commodities in the industry's output mix are literally harvested over a very short season once per year. This implies careful consideration of subsectoring possibilities for capacity and efficiency measurement. And it raises questions about whether measurement of capacity utilization any more frequently than once a year would be meaningful for important agricultural subsectors.

Alternative Capacity Measurement Approaches and Their Critique

The question now arises whether any of the methods described previously may be adopted for capacity measurement in the agricultural sector. The criteria of acceptability should include (aside from feasibility) the degree of accuracy that can be attained as well as the compatibility of the system with existing systems in the industrial sector. This last point is particularly important since increasingly a systemic approach taken in the analysis of the whole food and fiber sector includes industries located in both the agricultural and industrial sectors.

The Aggregate Production Function

Klein and Preston have experimented with and discussed an aggregate production function approach to capacity estimation for some nonfarm sectors. Their approach defines full capacity output in terms of the utilization of all available capital and labor in a production function of Cobb-Douglas form. However, Walters concludes that there may be no point in employing such a concept as an aggregate production function except over narrow sections of the economy.

We are not ready to say the aggregate production function approach is infeasible. But if we are mindful of the characteristics of agriculture noted previously, inclusion of all of agriculture in a single function may be too much heterogeneity for good results.

The Supply Function

A supply function is a schedule of quantities of a product that would be offered on the market at various prices. The function, however, does not reflect the source of the available goods. Some may have been derived from present production (i.e., may have been produced with the presently existing set of fixed factors) and some may have come from storage. Examination of the supply function could therefore not clearly indicate the level of capacity utilized for current production.

Nor is the supply elasticity indicative of capacity levels as is claimed by Hathaway. He

contends that supply functions become highly inelastic as "excess" capacity levels are attained. Since capacity is a short-run measure and since the supply function is inelastic in the short run (0.10 with falling prices and 0.15 with rising prices according to Quance and Tweeten), capacity utilization rates or capacity levels can not be "read" by interpreting long-run supply elasticities. It therefore appears that the supply function—at least at the present state of the arts—would not be applicable for capacity indications.

Equilibrium Price-Quantity Models

These models have been frequently used to examine price-quantity relationships in production and consumption. They have often yielded "explanations" of low factor returns or adjustment impacts on agriculture in terms of a concept of "excess capacity." But their use does not appear promising as part of a methodology designed to quantify the same concepts of capacity and its utilization that are quantified in the nonfarm sector.

The Wharton School System

While this system is by far the easiest of all those mentioned to use, a careful application of our criteria to its usefulness in the agricultural sector indicates that this method does not appear to meet our requirements.

The method requires an industry-by-industry analysis which is based on monthly or quarterly output data. It operates best in those industries which have a continuous annual output with fairly regular cyclical changes and which adhere rather closely to the movement of the business cycle, that is, a certain degree of coincidence in capacity utilization rates among the various industries is required to give effective index information for the sector as a whole. More precisely, they require a fairly equal distribution of peaks of output among all industries. Otherwise, capacity utilization rates would be determined for the sector by the distribution of the peaks rather than by their intensity. In the agricultural sector, continuous production is possible only in a few subsectors. Also the volatility in output in most of the agricultural industries would make adjustment of the full capacity line a serious problem and would provide an unacceptable data base for index construction.

Systems Employing the Survey Method

Application of the survey method (McGraw-Hill, BEA) for capacity index construction has considerable merit. It has proven successful in the industrial sector (Perry, p. 741). It is the only method through which producer intentions of expansion or restriction of capacity levels may be obtained. Similarly, only through this method can the preferred capacity utilization rate be ascertained.

While we are aware of the shortcomings of this system, particularly in terms of the time factor involved, we believe that this method warrants our serious consideration.[1] In recommending trial of the "McGraw-Hill Method" we suggest that the noted special characteristics of agriculture be carefully considered.

Implementation could involve a purposive sample of producers in various regions and in some of the major agricultural industries such as food grains, feed grains, industrial crops, and livestock. We would request information on three questions: the capacity utilization rate and the preferred capacity utilization rate, the rate at which the farm was operating during the preceding year, and the intentions of changes in fixed factors on the farm planned for the following year. We would necessarily need to assume that the producer (or manager) has some intuitive concept of the capacity of his farm which may be based on available acreage, machinery, or head of livestock. We also assume that he would not only be cognizant of the extent of use of his fixed factors but that he would be able to express any deviation from their full use in percentage terms. We similarly assume that he has in mind some—to his farm—economically optimal use of its fixed factors and the extent to which they differ from maximum operation. We finally assume that any planned change of capital stock can be expressed by him in terms of changes in total capacity. Special care would need to be given to the nature of this change, whether, for instance, newly acquired acreage comes from idle nonagricultural land on his farm, whether productive land is acquired from another farmer, or whether newly acquired land is from outside agriculture. Similar care should be exercised for cases of

[1] Since the BEA and FRB systems are mainly special refinements of the McGraw-Hill method, only the latter will be considered here.

acreage reduction and any transfers of capital stocks.

Farms participating in the sample should be grouped into subsectors on the basis of major activity and weighted by the value of total output. In contrast to the industrial sector, we would not have an industry-by-industry capacity breakdown, but rather a subsector-by-subsector analysis, which can be aggregated to the whole agricultural sector by participation weights. The resultant bank of information could then be related to a variety of factors pertinent to the agricultural economy and afford greater insight into the behavior of firms under various capacity pressure conditions.

We assume that continued experience on the part of both researchers and respondents would bring considerable improvement in the information obtained through surveys. In particular, we envision that a meticulous process of observing the actions of agricultural producers at various capacity levels and operating rates could lead to a set of conclusions regarding the impact of capacity pressures on the farm, the subsector, and the whole agricultural sector over time.

The Production Possibility Function

If we were to recognize some of the important characteristics of agriculture and experiment with subsectoring plans for the purpose of reducing the industry's heterogeneity, one such plan might result in the specification of feed-livestock and nonlivestock subsectors. Imagine, then, the existence of a production possibilities frontier, the estimation of which assumed fixed, currently available land and capital stocks, and presently used technology. The point on that frontier which represents the maximum combined output of both subsectors meets both the length of run and capacity level designation properties of capacity as represented in the McGraw-Hill, BEA, and FRB measures. Thus, it might be used as the denominator for the computation of a capacity utilization rate.

Then imagine an interior point representing current production from the same set of fixed factors and the same technology. The sum of combined subsector production at that point could be used as the numerator for the computation of a capacity utilization rate.

Further examination of the feasibility of this approach for estimation of agricultural capacity and its utilization is in process. The basic departure from approaches examined in the literature is in the identification of industry subsectors. One of the attractive features of this approach as a modeling framework is its possible feasibility through the use of either survey responses to capacity utilization questions or of secondary data.

Summary

Both of the latter two recommended systems may meet our criteria, particularly as they potentially relate to conceptual accuracy, feasibility, and compatibility with measures in the industrial sector. However, these methods offer no immediate series since it will take considerable time to develop the required data bank. The eventual outcome, we believe, will bring research results closer to reality than could be expected from the use of the other methods noted.

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Current Efforts at Estimation of Costs of Production in ERS

Ronald D. Krenz

The topic for this session indicates that we are dealing with the matter of issues in setting effective target prices. From examining the titles of the various papers to be presented, one would get the impression that the cost of production is important in setting target prices. This raises several questions that I would like to address. Is cost of production a good basis for setting target prices? If it is considered appropriate that they be used to set target prices, then what costs should be covered by target prices? How should these production costs be estimated?

Legislation

In passing the Agriculture and Consumer Protection Act of 1973, the 93d Congress established a set of target prices for some crops including wheat, feed grains, and cotton. These target prices were designed to be used as a basis for income payments to farmers if market prices fell below these levels.[1] These target prices were intended to be adjusted for the 1976 and following crop years on the basis of the index of prices paid for production items, interest, taxes, and wage rates, and further adjusted by changes in the three-year moving average yields.

This same act directs the Secretary of Agriculture to carry out studies of cost of production for wheat, feed grains, cotton, and dairy products. The act does not specify that the costs of production would be used to set target prices, but the implication is there. Also, requests for cost of production data from various Congressmen in recent months and recent proposed legislation would strongly suggest that cost-of-production data will be used as a basis for setting target prices, if not now, then in the near future.

Appropriateness of Costs

It is appropriate to ask, whether the cost of production is a good basis for setting a target price. From the standpoint of guaranteeing adequate returns to farmers' resources, it would appear that such an arrangement would be appropriate. This method seems more logical than the parity concept in which an index of prices paid was applied to a production technology used in 1910–14. Prices supported at the cost of production would seem to alleviate the fears of consumers that the government is subsidizing farmers at their expense. However, a price equal to the cost of production may result in more output of some commodities than consumers want to consume. Such a price may not be an equilibrium price.

Foreign trade must also be considered. How does our cost of production compare with that of our foreign competitors? Do we wish to compete in foreign trade? Perhaps we need to consider the effect on our balance of payments in foreign trade when we set target prices.

Hence, it seems appropriate that policy makers should have some liberty to depart from the cost of production in setting target prices. The policy maker should know what

The discussants for this session were Paul R. Hasbargen of the University of Minnesota, Robert C. Matthes of Kentucky Fried Chicken Corporation, and E. Clinton Stokes of the Chamber of Commerce of the United States.

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[1] These target prices are not to be confused with loan prices which serve as a "price floor" for Commodity Credit Corporation loan operations.

the cost of production is but should also consider other factors in setting the target price.

Input Pricing Problems

A second issue is, What costs should be covered? Costs of production on farms is a much more nebulous item to estimate than in an industrial organization where all inputs are purchased. Farm production utilizes several resources which are not priced in the market place. A farmer's labor and management is not priced in any market. It is often a matter of assumption as to an equitable return to these factors. A farmer wage rate can be inferred from the wage rate for hired farm workers but the rate of substitution is not clear. Also, no market exists for the sale or exchange of the managerial talents used on the typical U.S. farm.

Land Costs

Perhaps more significant is the cost of land. Land costs probably constitute the single largest cost item in agricultural production. They may account for 25%–40% of total production costs, depending on the method of estimation. The question revolves around the issue, What is farmland worth? As per Ricardo, farmland is worth what farmers are willing to pay for it, which depends upon what profits can be expected from production. Hence, land values are essentially based on current and expected returns from crop production. Setting of target prices will influence profits which in turn effect land values and hence, cost of production.

This could give rise to a wage-price type of ratchet effect. If target prices are set too high, land values will move upwards. As land values move upwards, costs of production will increase which will give the basis for further upward increases in target prices with an unending spiraling effect of rising farm prices and land prices. Perhaps this is more of a political issue than an economic issue. However, economists should inform the politicians of the likely impacts of such actions.

Perhaps target prices should be set to provide a floor to cover only nonland costs, letting returns to land become a function of the marketplace. If demand causes market prices to exceed target prices, then farm profits will rise and land values will be bid up. On the other hand, as market prices approach target price levels, land values may fall. However, farmers out-of-pocket costs would still be covered, allowing him to remain in production.

And what about the relationship between loan rates and target prices and production costs? Should loan rates be below or equal to target prices, or should loan rates be set to cover certain production costs but not other costs? What criteria would seem useful in this regard? Should target prices be the same for all regions if costs of production are different? Should target prices be set to cover costs of the average producer or at a high level to cover 90% or 100% of all producers?

Briefly stated, these are some fairly fundamental issues that need to be resolved. I do not expect to resolve them at this time, I only wish to bring some of these issues to your attention for further discussion.

Estimating Costs of Production

The remaining item that I wish to discuss is the matter of procedures in estimating cost of production and current efforts at cost estimates in the Economic Research Service.

Production costs in agriculture are extremely variable both among producers at one point in time and over time. In a given year, costs will vary between neighboring farmers due to differences in prices paid for inputs and due to size economies. For instance, in 1969 the cost of producing 1 pound of cotton lint was estimated to range from less than 15¢ per pound to greater than 39¢ per pound (Starbird and French). Production costs will also vary over time due to changes in these same factors.

As previously pointed out, some farm inputs such as labor and management are not priced in any market. These facts simply point out the difficulty of estimating the cost of producing farm commodities. Variation in costs make larger sample sizes desirable and calls for careful stratification and selection of the sample.

ERS Experience

Let me now discuss two somewhat separate but not independent cost-of-production efforts that are being conducted in ERS. These will

be described as the Firm Enterprise Data System (FEDS), and the cost-of-production task force.

Early in 1973, the Commodity Economics Division of ERS made a decision to proceed with the development of a systematic approach to development and updating of firm enterprise data. The purpose of this effort was primarily to collect and keep current over time enterprise cost data that would be available for research purposes including interregional competition types of supply analyses and for analysis of policy questions. The system thus established is currently known as the Firm Enterprise Data System (FEDS) which I will discuss in more detail later.

A few months later Congress passed the Agriculture and Consumer Protection act referred to earlier, calling for cost-of-production studies. This action was really an expansion of previous efforts rather than a new concept. Acting upon congressional request, ERS had conducted surveys in 1964, 1969, and 1972 on the cost of producing cotton. Hence, the 1973 act was really an extension to cover additional commodities.

As a result of the 1973 Farm Act, ERS requested additional funding for cost-of-production surveys. Such funds were obtained and early in 1975 a comprehensive survey of the cost of production of cotton, feed grains, wheat, and dairy was taken. Approximately 5,600 farm interview schedules were obtained in this manner. These data are now being processed and results should be available soon. This survey work is being directed by our ERS cost-of-production task force.

One of the major differences between these two cost-of-production efforts is that in the FEDS system we attempt to budget only an average cost of production for a given crop for a given geographic area. No estimates are made of the extent of variance in cost of production. On the other hand, the task force efforts with the large sample survey will provide both an estimate of the mean cost by geographic area and an estimate of the total distribution of costs. Such a distribution will indicate, for example, the percent of cotton produced at 20¢ a pound, percent produced between 20¢ and 25¢, etc. Similar estimates will be made for other products.

The cost-of-production survey effort and the budget system will probably both be continued in the future as both play somewhat different roles. The survey provides data on machinery types, sizes, and number of operations performed which serves as an update of technology of production. These data are not available from ERS or any other source. This will likely be done every three to four years. In the interim years, however, the budgeting system can use ERS data and other sources to update the production cost estimates as influenced by yields and prices.

FEDS Budgeting System

The FEDS system uses the Oklahoma Budget Generator which is a set of computer programs developed at Oklahoma State University by Kletke. This system, along with some additional programs that have been written, provides a completely computerized system for the development, modification, updating, and comparing of budgets.

The plan is to estimate average cost of production by crops by area for all major producing situations in the United States. Approximately 750 crop budgets are now stored on the system. These budgets depict approximately 93% of the acreage of wheat grown in the United States in 1973, 85% of the barley, 91% of the corn, 89% of the soybeans, 81% of the oats, 94% of the sorghum and virtually all of the cotton, rice, peanuts, and sugar beets. A few budgets on potatoes, tomatoes, sugarcane, hay, pasture, and silage are also included for some geographic areas.

At this time no livestock budgets have been completed. We are now developing the specification of machinery and equipment requirements for the livestock budgets and hope to develop a fairly complete set of livestock budgets during this coming fiscal year.

The crop budget data were assembled from a wide variety of sources, but primarily from ERS field men, experiment station, and extension service sources throughout the nation. During this first year the major emphasis was on trying to get a set of these crop budgets developed. Additional time must be spent on making these budgets comparable across commodities and geographic regions. During the coming year, data from the 1974 ERS Cost of Production Survey will be incorporated into these crop budgets so, hopefully, by January of 1976, a set of budgets will be available which will be comparable across the nation in terms of inputs and machinery technology.

The major responsibility of the FEDS staff

is that of processing the budget data and working on annual update and comparability. The bulk of the data used in the annual updating will come from the Statistical Reporting Service. This past year the budgets developed were generally based on 1973 farming conditions, yields, acreages, etc. These will be updated to 1974 during the fall of 1975. This set of crop budgets will constitute our historical set which will be updated each year as crop data for the previous year become available.

This set of historical budgets may not be appropriate for setting target prices from the standpoint of timing. In setting target prices, we should be concerned with production costs a year or two in the future whereas the historical budgets will be one or two years old. This would not be a serious matter except for inflation. These base historical budgets can, however, be used for projecting one or two years in the future. For instance, recently the 1973 budgets, along with projected yields and input prices, were used to project 1975 costs of production by crops, by regions for seven major crops.

This type of projection work will likely be continued in the future. This fall after the historical budgets have been updated to 1974, these budgets, along with projected prices and yields, will be used to make preliminary estimates of 1976 costs of production. These projected cost estimates should be useful as guides to policy makers in setting target prices.

Whole-Farm Budgets

A series of whole-farm budgets is also being planned within the FEDS system. The purposes of this budget series would be to provide estimates of current net incomes of typical farmers as influenced by prices, yields, and costs, and to have available for ready access a set of farm resource and cost data which can be used for quick analysis of impacts of various price and policy variables on net incomes of typical farms.

This series would in essence replace the discontinued ERS costs-and-returns series which provided a general type of economic information demanded by the general public. In this new series, all of the enterprise data for the typical farms will be obtained from the enterprise budgets. Given additional information on farm size, enterprise size, and other overhead cost data, a whole farm budget will be developed which will be entirely computerized and will show differences from year to year in net farm income for major types of farming situations in the United States.

Future Plans

Future plans for the FEDS system include expansion of the enterprise budgets to cover all the major crop and livestock enterprises plus the typical farms mentioned above. Some planning has gone into the idea of developing a computerized budgeting process for estimating costs in processing and distribution firms. With such a program, it would be possible to develop budgets for firms such as flour mills, slaughtering plants, feed plants, etc. The same computer technology for insuring uniform budgeting procedures, comparability, and updating procedures that has been found to be useful for farm enterprises could be put to use for these agribusiness firms.

Studies of economies of size or scale could also be made with such budgeting programs. Plant operations at various levels of capacity could be simulated and cost curves developed. Similarly, costs can be updated due to changing input prices or changing technology, thus giving estimates of marketing margins and cost components.

Conclusion

In recent years, significant advancements have been made in the use of computers in modernizing our methods of cost computations. The methods now available promise a vast improvement in terms of gaining comparability across commodity and geographic regions, in facilitating the updating from year to year that is necessary due to changing prices and technological developments, and also allowing the economist to budget unique situations with simpler types of data than were previously required.

What remains, however, in regard to establishment of target prices are the same conceptual problems that have always plagued economists, that is, how to deal with certain residual claimants such as labor and land, and the additional question, What does society want from its agriculture in terms of stability and production levels?

Where is the economists' role in this deter-

mination? Perhaps it is true that setting target prices does involve value judgments and political considerations. However, I think it is also quite obvious that economists must be available to provide data regardless of the legislation enacted and to indicate the implications of various target price determinations.

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Farmers' Production Costs for Corn and Soybeans by Unit Size

A. G. Mueller and R. A. Hinton

One of the issues in projecting changes in the level of target prices and loan rates that are a part of the Agricultural and Consumer Protection Act of 1973 is the differential effect on producers with different sizes of enterprises.

Agricultural economists generally accept the proposition that economies of size exist in agriculture. Budgeting studies and cross tabulations of total farm and enterprise costs by size of farm or enterprise have usually indicated lower costs and higher net returns to management and profits for larger farms and larger enterprises through the spreading of fixed costs of machinery and fuller employment of farm labor and management (Shaudys and Prigge, Van Arsdall and Elder, Wilken and Kesler). In a recent article, Krause and Kyle also hypothesized pecuniary gains in buying of inputs and marketing of products in addition to the cost savings resulting from size.

Study of Illinois Farms

Data on 1974 farm costs, returns, and performance from Illinois grain farms are summarized by size in acres per farm and average annual data are reported for 1968 to 1974 to reflect changes in costs over time.

A sample of 407 pure grain farms (no livestock) located on the topsoil types in forty-four counties of central Illinois were selected for study. All farms were enrolled in the Illinois Farm Business Farm Management Service and followed a consistent and uniform accounting system.

Size of farms ranged from 180 acres to 1,800 acres with an average of 1,220 acres for the open-ended group of farms of 950 acres or more. The sample of 407 farms was divided into seven size groupings and the range in size is not uniform among groupings, a consequence of utilizing an existing farm record data base without incurring the substantial costs of collecting and processing an independent data base. Data were also processed for a comparable sample of 433 farms in 1973 but because of space restrictions are not presented in this report.

Previous research has established that, although the overall farm record sample is in no way representative of a random sample of all farms, the separate size segments are representative of a population sample identified by the criteria of size, soil resources, geographical location, and farming system (Mueller 1954).

The traditional residual claimant analysis procedure is followed in estimating net returns to management and profits. Total returns are total cash sales of products and services plus change in inventory plus value of farm products consumed.

Cash costs per acre (tables 1, 3, and 4) are all calendar year outlays. Interest paid on any borrowed funds is omitted from cash costs and replaced by inputed interest costs on all capital. This adjustment is made because no identity of loan purpose in the basic data is available and a wide variation exists among farms as to amount and purpose of borrowed capital.

Unpaid labor costs are derived from reported months of available operator and family labor valued at a hired man's monthly wage rate ($625 in 1974). Depreciation on machinery and buildings is taken directly from accounting records used for income tax purposes and represents the business environment in which these farms operate.

The land charge reflects a normalized annual net rent for agricultural land. As calculated, the 5% land charge is a net figure since it excludes all landlord expenses and any returns from appreciation in land value. The base value of investment in land is derived from

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This paper is part of the University of Illinois Experiment Station Project 05-316, "Adjustments and Farm Growth by Illinois Farm Operators," which has an objective of monitoring annual changes in farm organization and performance on Illinois farms. The data base is farm record summaries on over 7,050 farms enrolled in the Illinois Farm Business Farm Management Service.

capitalized net rents and assigned to individual farms by a soil productivity rating determined by soil types found on the farm (Mueller and Kesler). The land value is adjusted annually by the March 1 index of land prices in Illinois.

An inputed interest charge of 8% was made on all other capital inputs using depreciated cost of machinery and buildings, inventory value of grains for six months' storage, and value of cash operating costs for six months. No management charge is inputed. This charge is reflected as a residual claimant in entrepreneurial returns and profits.

The costing procedure for estimating individual crop costs started with the aggregate data for the total farm (landlord and tenant costs combined). Using the aggregate costs data precludes making any determination of cost differences resulting from amount of inputs used and prices paid for the inputs, kind of capital, e.g., new or used machinery and sources and quality of labor. However, differences in level of costs and in performance can be determined from the accounting data, and farm returns, yields, and costs are analyzed. The aggregated cost categories are also disaggregated to show approximate level of specific costs per bushel as affected by yields and the costs for input categories.

Factual information from the farm record data base supplemented with subjective allocation methods for selected cost items is applied consistently among all seven size segments to allocate each category of costs between corn, soybeans, and other crops. Thus, the disaggregation errors, if any, are reciprocal between corn and soybeans within size cells and are consistent over size segments for either corn or soybean production costs. In the allocation procedure, residual variations for fertility costs are contained in the cost of producing corn. Tillable acres and other allocators are used for all other costs, with any sampling variations distributed to both corn and soybean costs within each size grouping.

Changes in Level of Costs and Returns, 1968–74

Since 1970, grain farms have faced more year-to-year variation in costs, prices, yields, and returns than in prior years. Table 1 shows the year-to-year average yields, farm costs, and returns on Illinois grain farms from 1968 through 1974. The cash and depreciation costs increased from $59 in 1968 to $69 in 1972, an average annual rate of 4%, to $84, a 22% increase, in 1973, and to $103, another 22% increase, in 1974. From 1968 to 1971 total costs increased 3.7% per year. In 1972, 1973, and 1974, increases in total costs per acre have been 11%, 17%, and 30%, respectively, over the preceding year.

The increase in total costs from $106 in 1968 to $200 in 1974 reflects, in addition to the increase in cash and depreciation costs, an increase in inputed interest charges for land and other capital investments and in the labor charge. Interest charges on land and nonland capital increased from $36 per acre in 1968 to $78 in 1974. Unpaid labor charges increased from $11 per acre in 1968 to $15 in 1974.

The annual returns reflect yields and the changes in level of prices received by these farmers. The annual costs and returns per tillable acre also reflect changes in the farm organization as farmers increased acres of row crops, particularly corn, as requirements for participation in feed grain diversion and set-aside programs changed during this period.

Farm Characteristics by Size

The organization characteristics of grain farms were similar for all sizes of farms from the smaller 180–259-acre group to the 950+-acre

Table 1. Costs and Returns per Tillable Acre on Illinois Grain Farms over 260 Acres, 1968–74

Items	1968	1969	1970	1971	1972	1973	1974
Number of farms	144	200	269	388	376	411	434
Tillable acres per farm	477	510	526	535	543	563	540
Corn yield, bu. per acre	102	130	99	136	133	130	103
Soybean yield, bu. per acre	37	42	38	44	45	40	31
Total returns	$100.76	$123.42	$124.48	$139.55	$170.29	$257.38	$315.09
Total all costs	$106.04	$106.81	$110.39	$117.55	$131.01	$153.69	$200.44
Cash and depreciation costs, excluding interest paid	$ 59.37	$ 58.10	$ 62.04	$ 67.67	$ 69.00	$ 83.91	$107.80

Table 2. Characteristics of Illinois Grain Farms by Size, 1974

	Size of Farm (acres)						
	180–259	260–339	340–499	500–649	650–799	800–949	950+
Number of farms	19	40	147	98	48	33	22
Total acres	226	300	423	560	717	862	1,220
Tillable acres	218	289	412	540	691	827	1,173
Corn, %	49.2	50.9	53.1	54.5	54.6	53.2	54.3
Soybeans, %	42.0	45.7	44.2	42.6	41.5	44.6	41.1
Soil productivity rating	95	94	95	94	95	95	92
Investment per tillable acre	$1,428.02	$1,390.82	$1,391.41	$1,414.93	$1,398.68	$1,406.06	$1,380.49
Land capital	1,117.80	1,111.40	1,117.80	1,111.40	1,117.80	1,117.80	1,098.40
Nonland capital	310.22	279.42	273.61	303.53	280.88	288.26	282.09
Months of labor	12.5	12.7	14.5	16.0	20.3	24.4	33.0
Farm income per tillable acre							
Custom work	$ 1.45	$ 3.54	$ 2.46	$ 2.34	$ 2.87	$ 1.98	$ 4.57
Refunds and miscellaneous	2.54	3.87	3.19	3.12	3.15	2.89	3.59
Grain returns	297.15	314.00	308.92	315.14	317.47	312.34	326.54
Total	$ 301.14	$ 321.41	$ 314.57	$ 320.60	$ 323.49	$ 317.21	$ 334.70
Farm costs per tillable acre							
Soil fertility	$27.45	$24.97	$26.50	$26.68	$30.16	$27.02	$28.00
Buildings	6.19	5.00	4.71	4.77	4.17	4.86	5.13
Machinery and auto	39.66	36.97	37.60	35.77	35.22	33.69	36.53
Labor	36.49	27.23	21.70	18.58	17.87	18.67	17.14
Seed and crop expense	17.06	18.00	17.48	18.29	18.56	20.19	21.56
Taxes	12.61	12.45	12.06	12.42	13.76	11.68	11.67
Miscellaneous	4.37	3.92	3.80	3.51	3.50	3.52	3.09
Interest on all capital	78.54	76.65	76.65	77.15	77.45	76.42	76.26
Total	$ 222.37	$ 205.19	$ 200.50	$ 197.17	$ 200.69	$ 196.05	$ 199.38

group (table 2). Except for the 180–259-acre group, all size groups had over 95% of their tillable land planted to corn and soybeans with a slightly greater proportion in corn than soybeans. The quality of soil was similar as reflected by soil productivity rating and the related investment in land capital per tillable acre.

The nonland investment per tillable acre (buildings, machinery and grain inventory) ranged from $310 to $274 per tillable acre with no consistent relationship to size of farm. The months of available labor increased as acres increased but with a less than proportional rate. Tillable acres per man equivalent (twelve months) increased from 209 acres for the smallest size group to 426 acres for the 950+-acre group.

The total farm income per tillable acre was greater for larger farms, reflecting higher yields and higher grain prices received. The total farm costs per tillable acre were higher for the two smaller size groups, but for size groups above 340 tillable acres, total farm costs were comparable.

Effect of Size on Unit Cost of Production

Unit costs of production for corn and soybeans in tables 3 and 4 follow the usual pattern of economic theory (Madden 1967, p. 2) with some exceptions. The small farms (180–259-acres) have the highest unit cost of production, largely because of high fixed labor costs distributed over only 199 acres of corn and soybeans. Unit costs trend downward until the farm size reaches 500 acres, but for farms over 500 acres to the largest sized sample, unit costs remain nearly constant except for the variation usually observed in empirical data. Since the available sample data do not extend to very large farms (over 2,000 acres), no observations of either continued decreasing or increasing unit costs are available to support or reject the usual theoretical concept of increasing costs for very large farms. Neither are the data capable of revealing a continuing decline in unit costs, except for the hypothesis that, using 1974 data, the cost curve is flat from about 500 to 1,200 acres.

Table 3. Cost of Production for Corn by Size of Farm, 1974

	Size of Farm (acres)						
	180–259	260–339	340–499	500–649	650–799	800–949	950+
Total acres	226	300	423	560	717	862	1,220
Total acres in corn	107	147	219	294	377	440	637
Yield per acre (bu.)	95	101	102	104	108	102	110
Cash costs per acre							
Soil fertility	$ 43.25	$ 38.29	$ 40.15	$ 39.56	$ 45.71	$ 41.17	$ 41.80
Seed and crop expense	21.42	22.85	21.85	22.57	22.78	25.26	26.45
Labor, wages, and perquisites	2.51	1.58	3.08	4.36	5.73	7.90	7.15
Machinery repairs, fuel, and hire	20.18	18.07	17.68	16.73	17.31	16.60	17.90
Taxes on land and improvements	12.60	12.46	12.05	12.42	13.75	11.67	11.68
Building repairs	1.63	1.89	1.13	1.38	1.15	1.48	1.97
Cash overhead expenses	7.04	6.62	6.08	5.38	5.22	5.15	4.48
Total cash costs	$108.63	$101.76	$102.02	$102.40	$111.65	$109.23	$111.43
Noncash and inputed costs							
Labor, unpaid charges	33.97	25.65	18.63	14.23	12.15	10.77	9.98
Machinery depreciation	19.70	19.08	20.45	19.67	18.72	18.12	19.78
Building depreciation	4.55	3.10	3.58	3.39	3.02	3.38	3.17
Land charge: tillable	55.89	55.57	55.89	55.57	55.89	55.89	54.92
nontillable	2.24	2.22	1.68	2.22	2.24	2.24	2.20
Interest on other capital inputs							
Machinery investment	4.37	3.96	4.17	4.19	3.89	3.87	3.79
Building investment	4.29	2.83	2.91	2.83	2.54	2.19	2.29
Stored grain inventory	10.26	10.91	11.02	11.23	11.66	11.02	11.88
Operating capital	4.34	4.07	4.08	4.10	4.47	4.37	4.46
Total all costs	$248.24	$229.15	$224.43	$219.83	$226.23	$221.08	$223.90
Cost per bu.	$ 2.61	$ 2.27	$ 2.20	$ 2.11	$ 2.09	$ 2.17	$ 2.04

Table 4. Cost of Production for Soybeans by Size of Farm, 1974

	Size of Farm (acres)						
	180–259	260–339	340–499	500–649	650–799	800–949	950+
Total acres	226	300	423	560	717	862	1.220
Total acres in soybeans	92	132	182	230	287	369	482
Yield per acre (bu.)	30	30	30	31	31	30	31
Cash costs per acre							
Soil fertility	$ 10.50	$ 10.50	$ 10.50	$ 10.66	$ 10.65	$ 10.49	$ 10.66
Seed and crop expense	11.95	12.60	12.24	12.82	12.99	14.15	15.11
Labor, wages, and perquisites	2.51	1.58	3.08	4.36	5.73	7.90	7.15
Machinery repairs, fuel, and hire	16.71	14.92	14.71	13.99	14.46	13.74	14.99
Taxes on land and improvements	12.62	12.45	12.06	12.42	13.76	11.68	11.68
Building repairs	1.62	1.88	1.13	1.38	1.16	1.48	1.97
Cash overhead expenses	7.00	6.67	6.09	5.40	5.23	5.11	4.50
Total cash costs	$ 62.91	$ 60.60	$ 59.81	$ 61.03	$ 63.98	$ 64.55	$ 66.06
Noncash and inputed costs							
Labor, unpaid charges	33.97	25.66	18.62	14.21	12.15	10.78	9.98
Machinery depreciation	16.33	15.75	16.99	16.43	15.66	15.04	16.54
Building depreciation	4.57	3.11	3.57	3.38	3.01	3.39	3.16
Land charge: tillable	55.89	55.57	55.89	55.57	55.89	55.89	54.92
nontillable	2.24	2.22	1.68	2.22	2.24	2.24	2.20
Interest on other capital inputs							
Machinery investment	4.37	3.96	4.17	4.19	3.89	3.87	3.79
Building investment	4.29	2.83	2.91	2.83	2.54	2.19	2.29
Stored grain inventory	5.88	5.88	5.88	6.08	6.08	5.88	6.08
Operating capital	2.52	2.42	2.39	2.44	2.56	2.58	2.64
Total all costs	$192.97	$178.00	$171.91	$168.38	$168.00	$166.41	$167.66
Cost per bushel	$ 6.43	$ 5.93	$ 5.73	$ 5.43	$ 5.42	$ 5.55	$ 5.41

Substitutions within the cost structure as related to size are also evident. Total cash costs per acre are slightly higher for the larger farms, as more hired labor is added to supplement the fixed operators' labor which is distributed over more acres. Except for the smallest group of farms, machinery cash expenses show no discernible trend related to size and neither does machinery depreciation. Cash expenses for seed and crop expenses, including crop chemicals, trend upward on the larger farms, off-set in part by lower cash overhead costs per acre.

Per bushel production costs for corn and soybeans based on five-year (1970–74) average yields (table 5) are consistent with the size relationships of per bushel costs using 1974 yields. Yields per acre of both corn and soybeans trend upward as size increases with the result that unit costs of production decrease from $2.24 to $1.85 a bushel for corn and from $5.36 to $4.27 a bushel for soybeans.

In addition to the yield advantage for the larger farms, the average selling price for both corn and soybeans on farms of 650 acres or more averaged 2¢ a bushel higher than on the farms under 650 acres in 1973 and 1974. Calendar-year sales and not crop-year prices were the basis for this observation.

The sample-selection procedure (grain farms with no livestock enterprises) unduly handicaps the very small farms. The usual organizational structure of farms with limited crop land typically includes supplementary or competing livestock enterprises that would more fully utilize the labor and other fixed inputs found on these farms, reducing the portion of these resource inputs to be allocated to crop enterprises. For this reason, the data on the very small farms need to be interpreted with care in policy deliberations.

Summary

This study reveals again the importance of fully utilizing resources available in discrete units, particularly operators' labor, in reducing costs of production. The results reported here for farms over 340 acres with fully employed operators are generally consistent with earlier hypotheses by Krause and Kyle on the effect of size of farm on crop production costs but with some observed differences. The significant departures from earlier studies are the observations that per acre cost curves tend to be more nearly flat in the range of 500 to 1,200 acres than previously hypothesized. On the output side, especially crop yields, the larger farms have an income advantage. A tentative hypothesis explaining this income advantage is that pecuniary economies of lower prices for purchased inputs by the larger farms are offset by the larger quantity of fertilizer, chemical, and machinery inputs used. This hypothesis is consistent with the higher yields observed on the larger farms and with marginal return concepts of economic theory.

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Table 5. Unit Cost of Production for Corn and Soybeans, 1970–74 Average Yields with 1974 Costs

Items		Size of Farm (acres)						
		180–259	260–339	340–499	500–649	650–799	800–949	950+
Corn:	Average yield	111	114	117	118	120	118	121
	Cost per bu.	$ 2.24	$ 2.01	$ 1.92	$ 1.86	$ 1.89	$ 1.87	$ 1.85
	Other income per bu.	.04	.07	.05	.05	.05	.04	.07
	Net cost per bu.	2.20	1.94	1.87	1.81	1.84	1.83	1.78
Soybeans:	Average yield	36	38	38	39	39	39	39
	Cost per bu.	$ 5.36	$ 4.68	$ 4.52	$ 4.32	$ 4.31	$ 4.27	$ 4.30
	Other income per bu.	.11	.20	.15	.14	.15	.12	.21
	Net cost per bu.	5.25	4.48	4.37	4.18	4.16	4.15	4.09

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Weather Variation as a Cost-Price Uncertainty Factor as It Affects Corn and Soybean Production

Roy Black

The process of attempting to predict climate and its resultant impact on agricultural output and prices is hardly a new venture. Herschel conducted a detailed study of solar activity in the late 1700s, noting an apparent relationship with severity of climate. He subsequently compared these relationships with wheat price statistics compiled by Adam Smith. Wallace, in 1920, used multiple regression methods to estimate the impact of meteorological variables on corn yield. This work contributed to the idea of the ever-normal granary. A number of studies examining climatic variability and food reserve policy were developed in the mid-1960s at the Center for Agricultural and Economic Development at Iowa State University and in the U.S. Department of Agriculture (Thompson 1966). Review articles on climatic change and its impact on agriculture include Bryson, Kalnicky, Newman and Pickett, and Thompson (1975). This article reviews an attempt to integrate climate into price-forecasting methodology, to develop supply implications for use in formulation of inventory policy, and to assess impacts on cost of production.

Conceptual Framework

An examination of the impact of weather on supply and demand functions provides a useful starting point. The impact on the production function and on producer strategies in resource and product allocation has received considerable study. Two points stand out. As variability increases, output forthcoming from the system for a particular input configuration is less than it would be under a less variable system. Second, producers, as a result of price and yield risk, employ fewer inputs than if their expected prices were held with certainty. These are important points to consider in forecasting planted acreage, yield per acre, and resources demanded. Further, since the demand for feed grains and soybeans is a derived one, variability in price and supply has a similar impact as on the supply side.

The precision with which weather variables can be forecast is an important element in the analysis. At the farm level, perception of the odds of alternative weather events influences the level of resource use including irrigation and choices among crop combinations. Impacts on financial management are substantial and contractual considerations, including the percent of crop to forward contract or hedge, must be carefully weighed. There is a tendency, as the level of aggregation increases, for good and bad events to cancel. But, even on the international scale, there is evidence drought periods tend to occur simultaneously in the feed grain and wheat-producing areas of the middle latitudes. In the mid-1930s, for example, yields were poor in Russia, Argentina, and Australia as well as in the United States. Thus, in developing projections for export demand, it becomes important to be able to characterize weather events on a global basis.

What is the evidence for cyclical patterns? Is drought a random event or does it exhibit a reoccurrence at regular intervals? It is important to recognize, at the outset, that there have been nearly as many climatic cycles reported in the literature as there have been "cycle hunters." Analysts must be exceedingly careful not to dredge up artifacts.

Much of the work in climatology is analogous to economics. Early work involved searching out empirical relationships, includ-

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The ideas presented were influenced by a number of agricultural economists, particularly G. Dike, L. Kyle, P. Hasbargen, and J. Ferris, as well as climatologist Dale Linvill. This work was conducted under Michigan Experiment Station Project 1229, "Improving Marketing Intelligence in the Food System."

ing attempting to find cycles. Later, climatologists moved toward developing more systematic general equilibrium models; in the last twenty years, much work has been done to develop computer simulation models of the earth's climate (Matthews, Kellogg, and Robinson). As in economics, fairly simple models may forecast as well or better than more complicated formulations. Budgets for research in this area have been expanded as a result of the importance in assessing man's impact upon climate.

The earth is a closed system except for energy from the sun; variation in solar activity and in the earth's orbit and tilt of the polar axis are the principal exogenous variables which determine climatic variation. (This section follows Lamb, and Newman). But only solar activity exhibits significant variation over relatively short periods. For example, a rapid change occurs when day turns into night as a result of the amount of solar energy that a point on earth receives; daily temperature exhibits a well-defined, twenty-four-hour cycle. Similarly, the rotation of the earth about the sun affects the amount of energy that various points on the earth receive, giving rise to seasonal changes in climate.

Sunspot activity, therefore probably solar energy, tends to exhibit cyclical behavior. Further, there appears to be a relationship between sunspot activity and climatic cycles; in North America and corresponding latitudes, sunspot activity and climatic change appear to be related in an approximately twenty-two-year cycle consisting of two eleven-year cycles. However, each eleven-year cycle is different; at the beginning of each cycle, the polarity of the magnetic field associated with sunspots completely reverses between the two solar surfaces. Thus, the charged particles reaching the earth's upper atmosphere from the sun behave differently from one cycle to the next.

The two cycles do not have the same influence on climate. In one eleven-year cycle (minor), sunspot activity has little impact on climatic change. In the other cycle (major), both maximum and minimum activity produce a shift in climate. Climatologists have observed striking differences in the general circulation of the earth's atmosphere from one eleven-year period to the next. Periods of drought tend to begin near the end of the minor-effect period as sunspot activity approaches a minimum; drought tends to continue until the following peak in sunspot activity during the major cycle. Major-effect minimum sunspot periods occurred in 1866, 1888, 1912, 1933, and 1954.

Periodicities in the sunspot cycle are well established with short-run peaks estimated at 10.9 to 11.3 years; however, prediction of maximums and minimums remains imprecise with cycles ranging between 9 and 13 years. A longer frequency, perhaps 90 years, has been estimated; if true, major characteristics should repeat themselves every 180 years.

Figure 1 depicts sunspot activity and drought in Nebraska for the last 200 years. Sunspot numbers for the major cycles are plotted above the "0" axis and for the minor

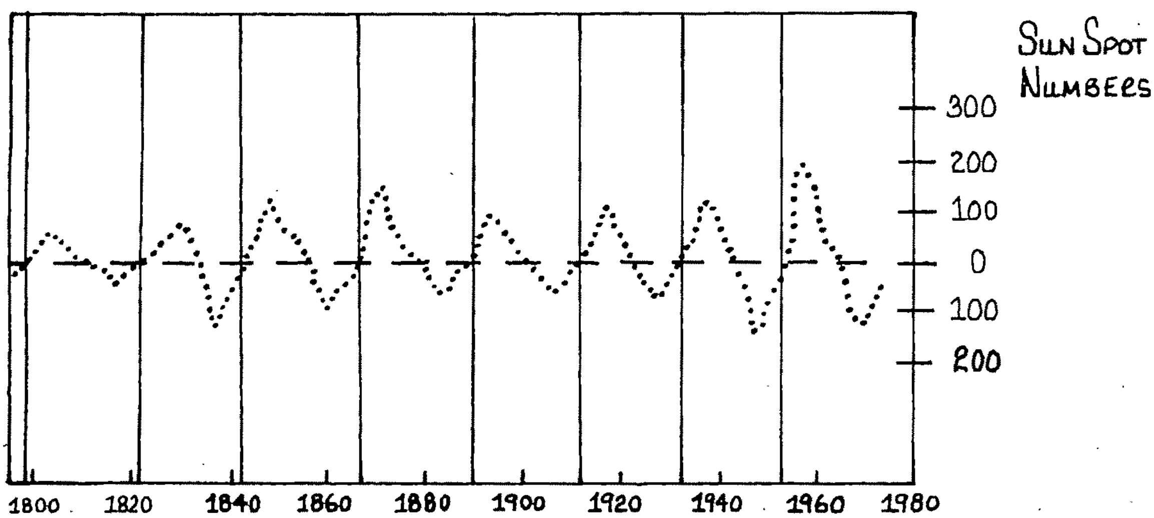

Figure 1. Solar cycle and drought in Nebraska

cycles below. Vertical lines depict the beginning of each major cycle; the horizontal lines depict drought periods. A relationship between sunspot numbers and drought exists, one too strong to ignore in decision making; however, a substantial portion of the variation remains unexplained. From a forecasting perspective, two problems exist. First, the start of the drought period relative to the beginning of the major cycle must be predicted. Use of a two-year lead has been a common rule of thumb that would have worked well for the 1930s and 1950s but poorly in earlier periods. Further, all Nebraska droughts did not end at the peak of the major cycle.

Figure 2, based upon Thompson (1970), depicts central and western Corn Belt corn yield levels adjusted to 1973 technology; vertical lines depict the period from the beginning of the major cycle to its peak. Forecast accuracy is improved by taking explicit account of cyclic patterns.

What about the 1970s? The current sunspot cycle, a minor, was projected in 1969 to reach a minimum in 1974–75; it has been longer than average, nearly thirteen years. More recently, December 1974, the minimum level of sunspot activity was projected to occur between late 1975 and 1977. The next cycle is expected to have a broad peak, perhaps reaching its maximum sunspot activity in 1982, a pattern similar to the late 1800s.

Forecasting 1975–76 Corn and Soybean Prices

An appraisal of our view of the role of applied price outlook, as it relates to management and policy decision making, is in order. Price forecasts and management decisions need to be considered jointly. For example, producers ask: "To what extent should I adjust production plans to expected changes in prices and in production relationships?" It becomes important to be able to characterize not only the expected value of the forecast but meaningful measures of its dispersion, perhaps including a description of the odds of different events where events are defined as prices or supplies forthcoming.[1] Too, knowledge of the range of

[1] Note that $E[f(x, y)] \neq f[E(x), E(y)]$ if $f(x, y)$ is nonlinear where x, y are random variables and E is the expectation operator. Further, in examining probability consequences, most weather data are not normally distributed and it appears year effects are often not statistically independent.

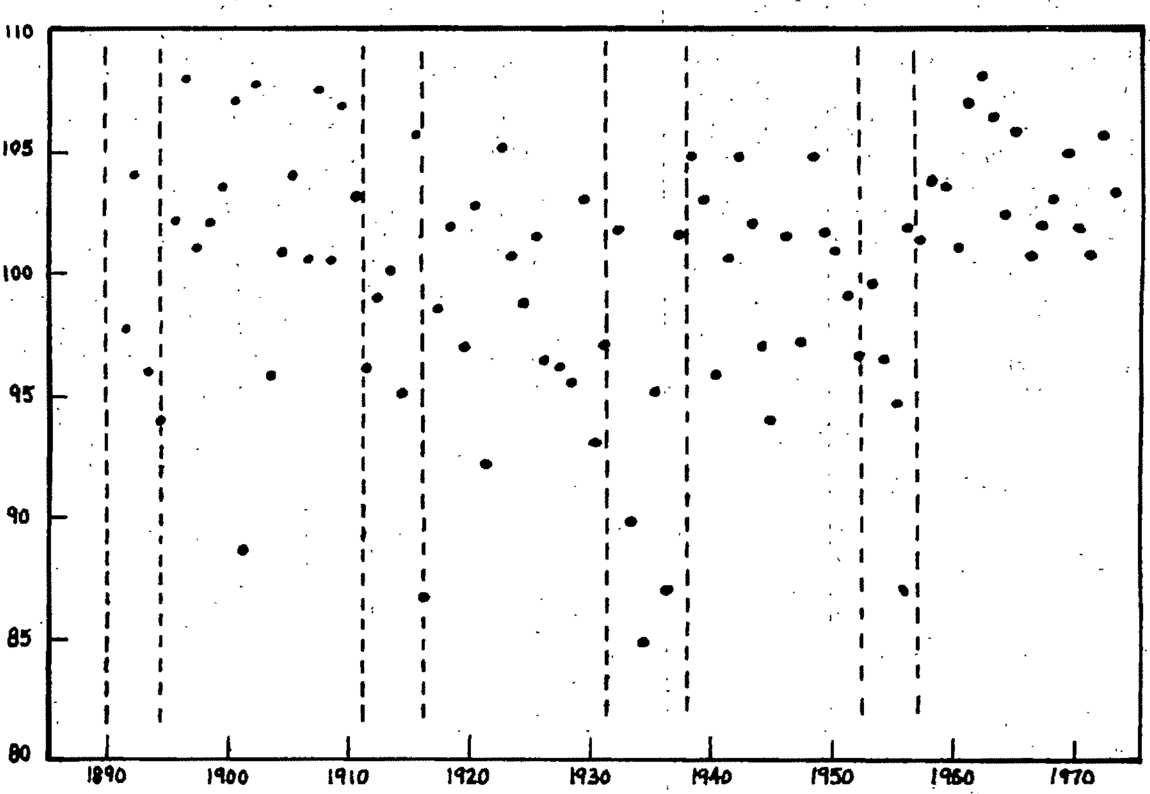

Figure 2. Simulated central and western corn yields using 1973 technology

outcomes and whether certain of the extremes which could arise under a strategy are acceptable is useful.

Therefore, in October 1974, a group of us with extension outlook, management, and policy responsibilities met to formulate our program for fall 1974 and 1975. With feed grain and soybean stocks expected to be near pipeline levels at the end of the 1974–75 crop year, weather was going to be a critical determinant of supply forthcoming. Our initial work was characterizing impacts of U.S. weather; subsequent events and a more detailed study of climatology suggests more effort should have been devoted to a characterization of weather on an international scale at the expense of other modeling work.

Our basic thrust was to estimate the odds of alternative corn, soybean, and wheat yields, to place each event in a general supply-demand framework to predict the probable grain, oilseed, and livestock prices associated with the weather event, and, ultimately, to develop the odds of alternative prices. The odds of alternative levels of export demand, based upon international weather events, were not developed; this was a critical shortcoming.

Table 1 depicts our estimate of the odds of alternative yield levels for corn. The odds were developed in a "quick and dirty" fashion consistent with our budget and time constraints. A trend was estimated for the period 1938–73, dropping the blight year. The odds were developed from the distribution of percentage yield deviations about trend; little formal work was done with the covariance of corn and soybean yields, although a high positive one was assumed in our price analyses.[2]

The next step required making adjustments from trend for 1975 conditions including seed quality, input availability, and the impact of fertilizer and chemical prices on application rates, land quality, and increased odds of drought in the western Corn Belt to establish an adjusted expected value. The odds were calculated with respect to that base. Table 1 was estimated in October 1974 with subsequent updating and revision.

What prices did we predict in October 1974?

Table 1. U.S. Corn Crop Prospects

Odds	Yield (bu. per harvested acre)	Crop (billion bu.)
1 in 15	75	4.9
1 in 10	83	5.4
1 in 5	87	5.7
1 in 3	91–92	6.0
1 in 5	96	6.3
1 in 15	102	6.7

The corn price associated with the most likely yield, 91 to 92 bushels per acre, was $2.40 per bushel, U.S. farm average for the crop year. A bumper crop, odds of 1 out of 15, was placed at $1.70 while the poorest crop was set at $3.25–$3.50. Prices in varying detail were calculated for the balance of the feed grain livestock sector. The forecasts were made available in our outlook extension program (e.g., Black and Ferris), to the U.S. farm press, to the U.S. Department of Agriculture and, to a limited extent, through project COIN (Hasbargen).

Further Implications

There are a number of shortcomings, the impacts of which we hope to reduce in the coming year. First, our climatological foundations were weak; much of what has been reported here has developed in summer 1975. As the crop year progresses, a general assessment of the conditional probability of different events based upon weather developments through the season should be made. Baker, for example, attempted to assess the odds of recharge of soil moisture for southwestern Minnesota. Finally, a more formal model with a strong international component is needed to improve the forecasting process and insure greater consistency. Work is well along here too.

The relevance of this framework for agricultural policy is readily apparent. The odds, for example, would be important in projecting cost per unit of production and governmental cost of alternative target prices. Work on the odds of alternative events, netted out on an international basis, is crucial to reserve policy including inventory policy formulation for the major grain-exporting firms.

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[2] Superior methods have been followed; a careful review of the literature is suggested. Unfortunately, the data series are not readily available. See, for example, Heady and Auer, Dale (1961, 1975), Doll, Johnson and Gustafson, Shaw, Stallings, and Thompson (1969, 1970, 1975). Problems include separating weather, technology, irrigation, and location of production impacts. Too, seasonal weather patterns influence crops differentially; it is possible for one crop to be excellent and another near disaster, given the same season.

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Livestock Aspects of Feed Grain Policy

Harold F. Breimyer and V. James Rhodes

It is a signal event that our topic should be included on this program. In recent years, the livestock and poultry economy has scarcely been considered in the making of price and income policy for feed grains. It has been disregarded by pragmatic policy makers. It has been almost equally bypassed by theoretical economists, who usually kibitz freely.

Policy for support and target prices for corn, grain sorghums, and other feed grains has been made with an eye almost exclusively fixed on the producers of those crops. The target price has been set relatively high in order to protect crop farmers' income. The latest (and current) loan rate policy has been to hold the rate low. Although a low rate facilitates moving grain into livestock and poultry consumption when crops are abundant, it does nothing to provide buffer stocks for years when crops are short. In addition, a couple of years ago it became administrative policy to dispose of the stocks inherited from an earlier period, even subsidizing their sale abroad.

But the foremost example of one-sidedness is the attitude toward release prices. In all the rhetoric heard recently about the peril of holding corn or sorghums in reserve, the scold has been that release prices would not be set high enough. What group can the spokesmen have had in mind? Feed producers, of course! Not feed consumers, that is, livestock and poultry men. It has been a one-sided consideration of a two-sided issue. If all groups are to have equal voice in policy making, how can livestock and poultry interests be so ostracized? The one-sidedness has more impact now that so much livestock and poultry production has become detached from feed supply on individual farms. The livestock-poultry economy is therefore more sensitive to the availability and price of feed.

It is in fact a contradiction that historically, livestock and poultry got more attention when they were still closely connected with feed production on the farm. In the early years of farm programs, the "ever-normal granary" was consciously designed to level out the supply and price of feed for livestock and poultry. Now that livestock and poultry have become more commercial and more vulnerable to a volatile feed situation, feed price stabilization has been progressively removed from the councils of farm policy.

And the ultimate contradiction is that the alleged price-depressing perils of a feed reserve have been proclaimed in disregard of the fact that the main defense of feed grain producers' incomes is the target price-direct payment mechanism, not support prices. If grains on reserve should cause market prices to be reduced below target level, producers would get bigger direct payments, that is, producers with a base on their farm are protected in that way. Admittedly, production outside such a base would not be eligible for payment.

Goals for Livestock Stabilization

If a price and income policy for feed grains is to be scrutinized for its effect on livestock and poultry enterprises, the possible reasons for doing so are few and easily recounted.

(*a*) One reason is to give some stability to operating margins in feeding and, therefore, to incomes of livestock and poultry producers. Less volatile feed prices would be in livestock producers' interest; this is self-evident. It is worth noting that livestock and poultry enterprises are essentially margin operations. This is true, in an accounting sense, even for farms that produce some or all of their feed. Economic efficiency is promoted by margin stability because instability tends to break the overexpanded and financially vulnerable producers, who frequently are not the inefficient ones.

(*b*) Another reason is to serve the interests of consumers. Consumers dislike the wavelike flow of meat and poultry products they have been subjected to. Wide fluctuations in availability can have at least two whiplash effects on producers. A prolonged shortage period can move the demand curve for livestock and

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poultry products to the left, worsening the price drop when supplies increase. If a shortage comes during inflation, the resulting price increases could create irresistible pressure for price controls.

(*c*) A price stabilization program for feed grains would also help to protect export markets for livestock and poultry products. This export counterpart of reason (*b*) is not extremely important. However, annual exports of livestock and poultry products run at about $1.5 billion, and vacillating supplies can do some injury.

(*d*) Highly unstable prices for feed grains introduce a risk element that can be devastating to the structure of the livestock and poultry sector. Breimyer has sketched possible directions it could go. The three choices present a paradox, for the first would be to push livestock and poultry back to the shelter of combined feed-livestock operations on individual (family) farms. Another would be the exact opposite, namely, to turn to nonfarm sources for risk-bearing capital. Limited partnerships, such as those used in cattle feeding (Meisner and Rhodes), or integration by conglomerate agribusiness might be encouraged. A third possibility is to set up a marketing board for each major livestock or poultry product, giving it broad powers to protect its markets and margins. This has not been the U.S. choice but might be opted for under duress.

(*e*) An operative price policy might also stabilize the demand for feed grains and thereby reduce shocks on grain producers, feed manufacturers, and government program operations. What we have in mind is the weak market that a bumper crop of corn may face in the fall of 1975 due to hog producers' having sold off so much of their stock. If the corn that the Commodity Credit Corporation disposed of so enthusiastically a few years ago had been used to sustain breeding herds of hogs this past year, the corn market for 1975–76 would be stronger. There is, verily, a mutuality of interest between feed grain producers and livestock producers where stability is concerned.

Alternate Policy Choices

Among several kinds of programs we list four that relate basically to feed grains and livestock and have indirect effects on livestock and poultry. A fifth applies to livestock and poultry and has indirect effects on feed grains.

For feed grains, we could implement no program; target prices but no price supports; target prices but no price supports and a government "accordion" program for exports; or a government managed program of reserve stocks, probably associated with various price support, target prices, and export activities. For livestock and poultry, we could implement price or income supplements. These could be combined with any of the four feed grain programs listed above. However, the more the price of feed is stabilized, the less would be the need for stabilization of returns to livestock and poultry producers.

A question will arise as to whether land retirement authority ("set-asides") under the Agriculture and Consumer Protection Act of 1973 would be involved in the first three alternatives. The assumption made here is that land retirement has not often been applied so effectively as to influence current market prices very much. Usually it has served mainly to reduce the government's obligation, including correcting a situation (such as excess stocks) built up in previous years. This assumption might be too heroic, but there is some advantage to keeping the number of alternate combinations down to a reasonable number.

Consequences of Alternate Programs

Principal consequences for livestock and poultry of the several alternate programs follow. If nothing whatever is done, markets will be "free," variable, and unpredictable. Nostrums such as using the futures market for stabilization can provide no aggregate solution, in our judgment. Risk will be high and will likely be transferred increasingly to nonfarm bearers. Alternatively, some commodity groups might adopt the marketing board scheme, absent from our shores until now. Buyers, domestic and foreign, will continue to view this solution as most unpalatable. Farmers, and the public institutions and private businesses connected with agriculture, will find themselves the frequent target of consumer wrath. Other nations—whether large importers or exporters—will turn even more toward measures to protect themselves from the fluctuations of our prices and supplies.

Whether we like it or not, the trend of the times is to resist high unpredictability and chronic variability in economic affairs.

A program based solely on target prices for feed grains would do much more for feed grain producers than for the livestock industry. Set high enough, target prices would stimulate feed grain production and thereby reduce slightly the chance of short harvest and reduced feed supply in any one year. It's a costly way, both politically and economically, of avoiding what can be accomplished with a feed reserve program. Target prices for feed grains, used alone, are the most partisan of programs. They stabilize feed grain growers' incomes, and do little good for livestock and poultry.

Conceivably, it could be official policy to use foreign trade as a weak market stabilizer. In fact, this has been our policy at times the past two years. Annual movement of feed grains is big enough that action to promote export sales in a big supply year and cut them back during stortage helps to stabilize supplies and prices for the domestic livestock and poultry sector. The disadvantage lies in consequences to foreign trade—both payment balance and foreign relations. One expands foreign exchange earnings by maximizing sales when world demand is strong rather than weak. It is unlikely that large and short crops of feed grains in the United States will be matched by strong and weak world demand. Thus, U.S. reserves are the prerequisite bridge to capitalizing on variable world demand. Moreover, it is easy to enforce the promotional features during flush supplies but difficult to impose restrictions when feed supplies are tighter. Feed grain producers, heedless of a balanced equation over time, would scream. Nor is it fair to the U.S. livestock industry to let state traders get the early market "bargains" in feed grains while our own feeders buy the residual supplies at higher prices.

The fourth proposal resembles the program that was in force for many years. The consequence will be shaped not by its broad outline, but by its specifications, that is, such an authority can in principle be used for whatever combination of ends is sought. There are many options as to how reserve stocks are to be acquired (by loan or by purchase and at what price), by whom and at what terms they are held, and how they are to be released (under what conditions and at what price). The system long in force was triggered by (nonrecourse) loan and release prices. Much can be said in favor of that method, but other signals could be used for acquiring and releasing stocks. We will indicate in our concluding comments our preference for this program. The crucial test is how wisely such a program is specified and managed. It is nice to lay out in scholarly fashion five alternatives and then check our choice, but sometimes not the basic design but the quality of implementation is what matters most.

The fifth alternative is perhaps the most original one we have set forth. We include it for completeness and not for advocacy, but if stabilization via feed supply should be wholly rejected, pressure for some sort of direct aid to livestock and poultry is predictable. It could be some kind of direct price or income supplement. Nor is there any a priori cause to reject it. Philosophically and politically, there is no valid reason why only the crop side of agriculture should be eligible for deficiency payments. Formulas for triggering them are no more difficult to draw up than those for crops. Further, the traditional resistance of the livestock and poultry enterprises to exposed direct subsidy is not a convincing argument. Sternly independent sheep and goat producers have not disavowed wool and mohair payments. A case can be made favoring direct subsidies over clandestine ones—over a consumer-paid subsidy via import quotas or duties or the income tax subsidy that has become so large in cattle feeding. Cattle feeding subsidies may have approached $200 million in 1973 (Rhodes; Woods and Carlin).

Deficiency payments to livestock and poultry producers would be more acceptable at times of oversupply and sharply depressed prices and feeding margins than in a year such as 1974 when scarce high priced feedstuffs squeezed feed-livestock margins. Consumers already paying what they regard as high prices for meat, milk, and eggs would look askance at dishing out a tax subsidy in addition. They would particularly object to subsidizing a farmer-feeder who might show a negative feeding margin but priced in his own corn at $4.00. More than that, when the feed supply is limited and reserves down to zero, a feeding subsidy would be largely self-defeating. Much of the subsidy would be bid immediately into the price of feed. This logical outcome would

be forestalled only to the extent that livestock and poultry producers would thereby bid feedstuffs away from export buyers.

Concluding Comments

We say again, we included the fifth alternative for completeness but also to warn that if feed stabilization be neglected too long, pressure can be anticipated from the livestock and poultry sector for authority to set up a marketing board, for deficiency payments, or for some other kind of aid or protection including high protectionism in foreign trade and even more income tax concessions. Gyrations in feed prices such as those of the last three years are not tolerable.

But it ought not be necessary to go any of those directions. It may seem anticlimactic to conclude that the kind of program we had for forty years is the best choice, but that is where we come out. Our fourth proposal does resemble the program of the 1930s and 1940s. It is more correct to say that the tools are the same. Those tools are adaptable to the different international situation which many believe we now face. To be honest, the present situation may make it harder to manage such a program. Exports of grains and other farm products are bigger now and more crucial to our balance of payments. By the same token we are more linked to world conditions which, to our amateur observers' eyes, seem to be becoming more unsteady. State trading, the demand for more reliable long-term commitments, and other considerations make it unlikely that even the best-managed program can achieve high stability.

We have warned that the case for the fourth proposal does not rest on a particular set of specifications. Almost the opposite is true: one of its merits is that it is inherently flexible and adaptable. If more details be insisted on, we offer a few. Question as to size of reserve always arises. It is almost misplaced. A reserve is not something to be held tightly at all times, like Silas Marner's money. By its nature it should move up and down constantly, responding to variable conditions of supply and demand. In a sense, the term "ever-normal granary" is a misnomer. If it does its job in keeping annual utilization normal, the granary will be ever-abnormal. If the reserve stays small and is frequently drained away, the program is too conservative. If the reserve stocks grow too fast and threaten to climb above, say, one-third of a year's production it becomes clear that support and release prices are too high.

If we want the program truly to stabilize on behalf of both grain farmers and livestock producers, the release price will not be pegged excessively high relative to support price. Perhaps 20% or 30% above support price would be high enough.

The fourth would moderate fluctuations in feed grain prices but not eliminate them. Thus, livestock and poultry industries would get the benefit of a substantial degree of stabilization in feed supplies and prices but could not expect all they would like. Viewed from the perspective of a total program to cushion shocks to the food system while maintaining our reliability as a supplier to foreign markets, there is a trade-off between grain reserves and livestock production. The livestock industry cannot expect policies which isolate it entirely from vagaries of world weather or world economics, but it can benefit from a reserve program which appears consistent with broader national objectives.

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Policies and Programs to Alleviate Poverty and Unemployment (Glen C. Pulver, University of Wisconsin, Chairman)

Will Public Service Jobs Cure Unemployment?

Thomas F. Hady

The assigned title for this paper is an excellent example in support of the principle that hindsight is better than foresight. Initially, I agreed to the title, but the longer I studied the subject the less comfortable I became with it. Will public service jobs cure unemployment? seems to imply one of two questions. It may raise the question whether public service jobs are capable of curing unemployment, and this is an issue about which I have something to say. It may also be asking for a prediction about whether public service jobs will, in fact, be used to cure unemployment. On this issue, I regret to report that my crystal ball is very cloudy. More broadly, though, the issue might be posed, Should public service jobs be used to cure unemployment? This issue embraces the question of whether these jobs are capable of curing unemployment, but it allows a number of other considerations as well. It is to the economics of this question that I propose to address this paper.

Back in 1959, Richard Musgrave provided a framework which is useful for analyzing issues of this kind (chap. 1). Musgrave suggests that the public sector can be thought of as consisting of three branches: an allocation branch, a distribution branch, and a stabilization branch. The allocation branch is concerned with the allocation of resources among competing ends. It has a balanced budget, and it operates in pursuit of economic efficiency in a Pareto optimum sense. The distribution branch is concerned with the interpersonal distribution of income. It, too, operates on a balanced budget but its concerns are with equity questions in the distribution of income. Finally, the stabilization branch is concerned with stabilizing the economy. It does not operate under a budget balancing constraint.

These three categories provide a useful framework for analysis of public service job programs. But before proceeding, public service employment should be defined specifically. Although governments have employed citizens for several millennia, our attention is clearly restricted to a much smaller set—to people who for some reason cannot find jobs in the private sector, at least at the current stage of the business cycle. For purposes of analysis, we also need a standard of comparison. I take this to be the effects of a system of income guarantees financed by the same taxes and producing the same income distribution as the proposed public employment.

Within this framework, the allocation branch would appear to have little interest in public service employment. If one assumes that through a voting process people instruct their governments to provide public services which yield marginal utilities roughly equal to the marginal utility of their private services, there would seem to be no room for public service employment to improve resource allocation. But the case is not that clear. Difficulties with voting as a process for articulating these kinds of choices have been recognized at least since Arrow first pointed out his voting paradox in 1951. Economists of the Galbraith school have argued for some years that there is an institutional defect in that private goods are subject to wide advertising whereas public goods typically are not. If there were equality in sales promotion there would be a different mix, involving more publicly produced goods.

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The opinions expressed are those of the author and not necessarily those of the Economic Research Service or the U.S. Department of Agriculture.

There is the public choice school which argues in part that decision making in large governmental units leaves many citizens with more or less public goods than they really want and suggests that there are alternative structures which will come closer to satisfying everyone.

More generally, the assumptions which insure that a condition of competitive equilibrium is also Pareto optimal—that Adam Smith's invisible hand really allocates best—are very restrictive (Koopmans). It is most unlikely that they will be fulfilled in any modern economy. If they are not, it is entirely possible that there is some better allocation of resources in the sense that it will make at least one person better off while leaving no one else worse off. But I see no clear grounds on which to argue that this allocation of resources would involve greater employment by the public.

The second broad category which might be used to justify greater public service employment, the distribution branch, is concerned with alterations in the personal distribution of income. Hence, we are discussing the use of public employment to combat unemployment and poverty that is not related to the business cycle but rather to some sort of structural problems. There are several ways in which these types of problems can arise. One that we hear about with some frequency is the so-called "culture of poverty." Essentially the argument is that we have individuals and groups in our society who have lived in poverty and on welfare for so long that they are unwilling to make the sacrifices necessary in order to obtain and hold a job. The issue of how widespread this culture of poverty may be is too broad to treat adequately in this paper. However, there is evidence to suggest that if it exists at all, it is not so widespread as many would believe.

A group of studies in rural areas of Arkansas were recently undertaken to look specifically at the issue of whether a culture of poverty was a major deterrent to upward job mobility among the economically deprived. The authors concluded: "Certainly, there are individuals and families in the study areas for whom the 'culture of poverty' is an accurate description. Data from these studies merely indicate that the *number* of individuals for whom the poverty culture description is accurate probably has been overemphasized. Little evidence was found in these studies to suggest that the 'culture of poverty' is a dominant mode of thought among the poor, or that it can safely be used as a basis for generalization" (Grinstead, Green, and Redfern, p. 12). Other factors, including health problems and transportation problems, were found to be significant deterrents to increased employment among the rural poor.

A second category includes those individuals who lack skills demanded in the present-day economy and who are not likely to be able to acquire those skills. Some of these individuals are disabled or are too old to work. Clearly, a public employment program can be at best of very limited value for such people. Beyond establishing sheltered workshops, a controversial subject in itself, there is little that public employment programs can do for these individuals whose basic problem is their physical inability to hold gainful employment.

There is a group, however, who might be served by public employment programs. These are people who are physically able to work but who do not possess skills which are in demand in their labor market. Some of these people might be helped to relocate. Others will need retraining. As a part of the retraining process, public employment may have a significant role. Integrated with classroom instruction, it may provide an excellent opportunity for on-the-job training in certain areas. Also, it will help to overcome the difficulty faced by many underemployed people, that of supporting themselves while enrolled in a training program. Thirty percent of the respondents in the Arkansas study indicated that they had not participated in job training programs because they were unable to quit work to enter training (Grinstead, Green, and Redfern, p. 24). It should be noted that this last problem can be overcome equally as well by an income supplement program. The conclusion on this point is that there may be a limited role for public employment, principally as a source of on-the-job training, but retraining programs do not appear to be likely to justify major public employment programs.

The question remains of what to do with those physically able individuals who lack necessary skills and who for some reason or other cannot be equipped with new marketable skills. Chief among these are the individuals who are far enough along in their working careers that they will find it very difficult to change to a new way of life. For these individuals, public employment could be visu-

alized as a long-term alternative to income supplement programs or welfare. Furthermore, it has an appeal to the average voter. He thinks he is getting something for his expenditures. Income supplements, on the other hand, may be viewed simply as a "dole" to people he does not understand and has no real desire to understand.

But these conclusions need to be viewed with considerable caution. As a practical matter, a public employment program may have to include many individuals who otherwise would be employed privately. Further, the real administrative costs of the public employment program may be greater than those of an income supplement program of similar size. If so, society may not realize a net gain from the public employment of these workers either. Clearly, society is more likely to gain from public employment programs if current public employment makes use of substantial numbers of individuals with comparatively low skill levels that are common in the group of disadvantaged we are talking about employing. If new tasks must be made to employ this unskilled labor, their productivity seems more questionable.

To investigate this point further, a series of statistics on the skill levels of public employees would be helpful. Unfortunately, I have not been able to find such statistics. The observations of twenty years of continuous state and federal employment, however, cause me to suspect that the distribution of skill levels among government employees is not much different from that of the private sector. Governments find it about as difficult to design productive employment for unskilled workers as does modern industry.

Compared with an income supplement program for redressing inequities in the income distribution, public employment seems to have a fairly limited role. It probably is not a useful tool for individuals without employable skills. It may be a useful tool as an adjunct to a retraining program to provide new skills for otherwise employable people. Its usefulness for individuals who are basically employable but who lack skills currently demanded in the market place and are not likely to be able to absorb those skills seems more questionable. Public employment may have a limited role in this area, but income supplements seem likely to be a more efficient solution in the majority of instances.

Finally, we come to the third broad category of reasons why government might engage in public service employment, those embraced in Musgrave's stabilization branch. For those of us who were in graduate school in the 1950s, there was little question but that the answer to the question in the title of my paper was "yes." This was simply a particular form of increased government expenditure, and we all know that $y = c+i+g$. We might discuss the advantages of this form of fiscal policy compared with others and condemn the "leaf raking" school of public relief, but the possibility that public employment might be ineffective as an anticyclical measure never really occurred to us. Milton Friedman was a solitary voice.

As I understand the current thinking in the economics profession, we are not nearly so confident that we know everything, or nearly everything, important to know about cures for inflation and recession as we were some years ago. In particular, while most economists probably will not accept the extreme position that only money matters, most will probably agree that money matters. It makes a difference how the public employment is financed, that is, the effects differ whether it is financed through increased taxes or through an increased deficit. In addition, the way in which the government finances the deficit, and the way in which financial markets react to that financing, is of considerable importance. Advocates of the "crowding out" phenomenon apparently are trying to tell us that it is possible for deficit financing of a public employment program to so interfere with private investment that the program creates as much unemployment as it resolves and becomes self-defeating.

The majority of our profession, however, probably is not willing to go that far in condemning the usefulness of fiscal policy. If we admit to the usefulness of fiscal policy, then the logical next question is the proper role of public employment as one element in fiscal policy. After all, there are numerous other tools available. To fight a recession, we can reduce taxes, we can increase transfer payments, or we can engage in other forms of government spending. (Furthermore, of course, one can discuss which taxes to reduce and in what ways, etc.)

The advantages and disadvantages of changes in taxes and transfers, compared with changes in government resources-using expenditures, are beyond the scope of this

paper. However, it may be of some value to consider briefly some of the pros and cons of public employment versus other forms of government resource-using expenditures. If the purpose is to increase incomes of the disadvantaged, direct government hire may be more cost-effective than, for example, purchases of goods and services from private business. There is less leakage into profits, into additional wages and salaries to individuals who are already employed, and into similar places.

On the other hand, public employment has certain disadvantages. As compared with purchases from private business, it may be harder to start and stop. Starting it up means creating a new organizational structure, whereas private business already has that structure. (Preserving the private business structure may be an advantage of direct purchases in itself. It may help to facilitate later recovery.) Once a public payroll is set up, a variety of forces come into play which make it difficult to reduce that payroll.

There may be a limited set of government expenditures on which timing is not urgent. A community may need a new post office, but this may be an expenditure which could be made any time in the next five to ten years. Such expenditures might well be handled on a counter-cyclical basis. Perhaps some of them can be done most practically by the government directly rather than through contract with private industry. But this appears to be a fairly restricted set. In sum, the logical instances for public employment as a stabilization measure, short of a long, drawn out depression like that of the 1930s, seem to be limited.

There are two sets of factors given very little attention in this discussion, the social and the political. From a social viewpoint, public employment may have important advantages over income transfers, in the sense that it may seem less like a dole and, therefore, be less degrading to its recipients. Apparently there remains a sizable number of Americans whose pride will not permit them to accept welfare.

There may also be some other social reasons for public service employment programs. For example, the unemployment rates among youth, and particularly among black youth, are disquieting. It may well be that public service employment programs aimed at these groups would be more effective than income supplement programs in not only providing them with an income but giving them an opportunity to mature into fully productive workers. The continuing costs to society of drug addiction, crime, and other problems which are likely to accompany idleness, might also easily outweigh the marginal costs of administering a public employment program.

From a political viewpoint, public employment programs may be easier to enact than income supplement programs. Hence, the practical choice in some circumstances may be between helping people through public employment or not helping them at all. Under these circumstances, many of the observations I have made are clearly inapplicable.

To summarize, the case for a major expansion of our program of public service employment is, at best, uneasy. On resource allocation grounds, while there is room for argument it is difficult to make a clear case. On income distribution grounds, there are some specialized instances in which public service employment may be superior, but in general, the decision must go to income supplements. On economic stabilization grounds, there also are instances in which public service employment would have potential advantages, but other measures seem to be indicated in a large proportion of cases. However, in the instance of some specific groups, such as youth, the case for public service employment may be much easier to support. Indeed, if we eventually decide to institute a broad scale program of public service employment, rather than an income supplement program, the prevailing arguments will have been social rather than economic.

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The Impact of a Universal Income Maintenance Program on Income and Employment

D. Lee Bawden

This paper will assess the income and, to a lesser extent, the employment effects of replacing public assistance and food stamps with a universal income maintenance program. Attention will also be given to how and why these programs impact differently on the rural and urban poor.

Present Cash Transfer Programs

There are presently three public assistance cash programs—Supplemental Security Income (SSI), Aid to Families with Dependent Children (AFDC) for one-parent families, and, in about half the states, Aid to Families with Dependent Children-Unemployed Parent (AFDC-UP) for certain low income, two-parent families. These programs are categorical in nature in that a family cannot qualify on the basis of low income alone, but must meet other eligibility requirements. Among the poor, the least adequately covered by these three programs is the so-called working poor—two-parent families in which the head is able-bodied and of working age. About half of the nation's poor live in such families, yet less than 10% of those families receive any public assistance (Blechman, Gramlich, and Hartman, p. 180). Nor does Unemployment Insurance (UI) do much to fill the gap. Almost half of the male heads of these families work full-time the entire year. Many others receive no UI benefits because they are not covered, because they have been unemployed too long, or because they have had short but frequent periods of joblessness.[1]

The only transfer program to which the working poor are universally entitled is the Food Stamp Program. The Food Stamp Program, now offered in all states, is available to all low income families, but benefits are conditioned upon income. Because of the relative newness of the program and because of limited outreach efforts, participation in the Food Stamp Program among eligible families is quite low—estimates range from 30% to 60%. Participation among eligible families headed by a nonaged, able-bodied male, however, is even lower—around 15%.

A Universal Cash Transfer Program

Because of the exclusion of the working poor from most cash and in-kind assistance programs and because of other inequities in the existing public assistance programs (e.g., the wide variation in payments among states), serious demands for reform of the present cash transfer system were made as early as 1966. In 1969, Richard Nixon became the first president to propose a universal cash transfer program for which eligibility would be based solely on family income; all poor families (but not single individuals) would therefore be eligible for assistance. Despite this being labelled by Nixon as his number one domestic program, it was never enacted into law. It passed the House Ways and Means Committee twice, only to be bottled up in the Senate Finance Committee.

In early 1973, then-President Nixon asked the Department of Health, Education, and Welfare (HEW) to once again come up with a universal cash transfer program to solve the so-called "welfare mess." A task force was formed in HEW in August of that year and over the next twelve months they developed a program which was first presented to Nixon prior to his resignation and which has since been presented to President Ford. The basic elements of that program are: (*a*) an income

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[1] The recent temporary legislation extending the payment period and covering previously uncovered workers has improved the situation somewhat.

floor for all families, scaled by family size and age, which would give $3,600 to a family of four with no income and headed by a nonaged person; (*b*) a negative tax rate of 50%, meaning that for each dollar of family income, benefits would be reduced by 50¢; (*c*) a declining scale of cash transfers which diminish to zero as a family of four reaches an income of $7,200 per year; and (*d*) a work requirement which stipulates that nonaged able-bodied males must register for employment and accept a "suitable" job offer in order to remain eligible for the cash payments. The proposed program would replace all existing public assistance cash transfer programs, the SSI, AFDC, and AFDC-UP, and the Food Stamp Program, with a net cost of between $3 and $5 billion.

Tax relief for low and middle income families is also part of the proposed package. The minimum standard deduction would be raised so that personal exemptions plus the standard deduction would be $7,200 for a family of four. This coincides with the $7,200 break-even level for the cash transfer program, insuring that a family would not both receive a cash transfer and pay personal income taxes. The cost of the tax relief component would be roughly the same as for the cash transfer program.

While initially receptive to this proposed program, President Ford decided to keep the proposal under wraps for at least another year. Welfare reform fell prey to the larger policy objective of halting inflation.

Impact on Incomes

Under the administration's proposed program—tentatively called the Income Supplement Program (ISP)—cash transfers to the aged (as well as to the blind and disabled) would remain virtually the same as under the current system. SSI would merely be merged with ISP into one administrative unit. Secondly, in most states, female-headed families would receive no higher payments from ISP than from the current AFDC program. They might, in fact, receive lower payments, depending on the extent of state supplementation. In sixteen states, female-headed families would be treated more generously. Most of these states are in the South.

The major difference between a universal income maintenance program like ISP and the current set of welfare programs, however, is that all poor nonaged, male-headed households would be eligible for cash assistance. About half of the poor people in the United States live in such families and, at present, a minority of these receive food stamps or AFDC-UP payments. Under ISP, the average payment to this group, the working poor, would be about $100 per month for a family of four, supplementing average earnings of about $400 per month, or an increase in net family income of about 25%.

The impact of ISP upon the number of families below the poverty line would be sizable. The present mix of SSI, AFDC, and food stamps transferred about $13 billion in federal monies to the poor and near-poor in the past fiscal year, raising approximately one-fifth of all pretransfer poor families above the poverty line. A program like ISP, on the other hand, would add another $8 billion and would raise about half of the pretransfer poor families above the poverty line. (These and the estimates in the following paragraph are from the Transfer Income Model, TRIM, of the Urban Institute [Bergsman et al., Koenig, Moeller].)

These figures, of course, understate the impact of adoption of a universal cash transfer program like ISP because they merely count the number of families moved across the poverty line. More significantly, such a program would set an income floor for families, below which family income could not drop (for a family of four this would be $3,600). It would close the poverty income gap by almost 75%, and would substantially raise the economic status of the poorest of the poor.

Impact on Employment

There are two potential employment effects from adoption of a universal income maintenance program. One is the multiplier effect on job creation from distributing additional government funds to consumers. The second is a possible reduction in labor supply due to the implicit tax on earnings of an income-conditioned transfer program.

Assuming the government uses increased tax revenue to finance the additional cost of a universal income maintenance program, there will be no change in the budget deficit. There may be a multiplier effect, however, because the transfers will go to low income families, which have a higher marginal propensity to consume than the higher income families from

which the taxes are collected. Any increased employment arising from the marginal increase in the multiplier effect should be small, however.

Another factor is the geographic redistribution of funds arising from such a program. States with low public assistance payments, mostly in the South, will benefit relative to those states with higher payments under the present public assistance programs. So there will be some geographic redistribution of funds under a universal income maintenance program and, hence, some geographic redistribution of employment created by the relative shift in funds. Again, however, the effect would be small.

The third and more widely discussed effect on employment from adopting a universal income maintenance program is a reduction in employment due to a decrease in labor supply of the recipients. This reduction is hypothesized to be the result of both an income effect (the size of the payment) and a price effect (the result of taxing earnings or the reduction in benefits due to an increase in earned income).

One must compare the universal program to each of the present public assistance programs to determine the potential effect on work effort. SSI, the program for the aged, blind, and disabled, now taxes earnings at 50%; so ISP, with its tax of 50% should result in no effect on work effort.

AFDC has a tax rate of 67%, though this rate is not necessarily uniform over all ranges of income. The 50% tax rate of ISP should have some positive effect on work behavior. Estimates of the sensitivity of work effort of female heads to a change in the tax rate suggest that employment would increase anywhere from 3% to 10% (Garfinkel).

The largest work response engendered by an ISP-type program may be on the part of the so-called working poor. Except for the few receiving AFDC-UP payments, the largest negative tax rate encountered is 30% by those receiving food stamps. Most of the working poor receive no income-conditioned transfers; hence, their only tax on earnings is from the payroll tax and, if their earnings are high enough, from the personal income tax.

It is the uncertainty of the work response of this group which has been a major impediment to the adoption of a universal income maintenance program. Because of this uncertainty, four experiments designed to address this issue were initiated in the late 1960s and the early 1970s. The first experiment, focussing on urban families in the northeast, showed that the reduction in family earnings due to a 50% negative tax on earnings was in the neighborhood of 5%. (This figure is a composite of the results reported by Rees [p. 176], weighted by an appropriate proportion so that the experimental subsamples are representative of the entire U.S. population). Most of this was due to a reduction in work on the part of wives.

Work behavior in response to this experiment cannot be extrapolated directly to a national program like ISP for several reasons, the most important being that there was no work requirement in the experiment, whereas the proposed ISP program would have one. How strictly it is enforced would influence the amount of work disincentive expected, but in any case it should be less than in the experiment. The 5% figure, therefore, should be an overestimate. If this 5% is assumed to be appropriate for all working poor families receiving ISP payments, then the amount of earned income lost would be around $800 million, some 10% of the total cost of the ISP program. Adjusting this for a work requirement and for the fact that female-headed families should show some incentive, the loss in total earned income should be quite small.

Rural-Urban Differences

A universal income maintenance program would have a significantly different impact on the rural poor compared to the urban poor. This is due principally to the difference in the demographic composition of the respective groups, and, less importantly, to the lower participation of the rural poor in present programs.

In 1970, only 26.6% of the U.S. population lived in rural areas (i.e., farms and in towns of 2,500 or less), but 35.5% of the total U.S. poverty population were rural residents. Moreover, the make up of the rural poor was slightly different from the composition of the urban poor. In rural areas, only 13% of poor families were headed by a female, while 24% of urban poor families were female-headed. A second difference was in the age distribution of the poor. Of all poor single households and families in rural areas, 41% were headed by persons 65 years of age or older. The comparable figure for urban areas was 36%. So a

larger proportion of the rural poor were in male-headed families and a larger proportion were older, compared to their urban counterparts.

These statistics are significant in evaluating the effect of a universal cash transfer program on the rural poor. Under ISP, cash transfers to the aged would remain virtually the same, so there would be no rural-urban differences among this group. Among female-headed families, the gainers would be in states which now have low AFDC payments, principally the southern states. Since there is one rural to every two urban households in the South and only one rural to every eight households in the entire United States, the rural poor would benefit proportionately more than the urban poor from ISP.

A third factor is that ISP would also replace the Food Stamp Program. Currently, participation in the Food Stamp Program is higher among the urban than among the rural poor. The rural poor make up over a third of the total U.S. poverty population but they represent less than a fifth of the food stamp recipients. Relatively speaking, the rural poor would "lose" less by the elimination of this program.

The major reason that the rural poor would fare better than the urban poor under ISP is because poor families headed by a nonaged, able-bodied male would be eligible for cash assistance. This feature of the program, more than any other, would cause a proportionately larger share of ISP monies to flow to rural areas. This is because nearly two-thirds of the rural poor are in nonaged, male-headed households, whereas only half of the urban poor are in such households.

In summary, rural areas would benefit relatively more than urban areas by the adoption of a universal income maintenance program. Since we do not yet have accurate figures of Food Stamp Program benefits by income class and place of residence, precise calculations cannot be made of the reduction in the number of poor families under an ISP-type program. Some approximate calculations, however, show that the adoption of ISP would reduce the number of rural pretransfer poor families by 56%, compared to a reduction of 16% by current programs or a net decrease of 40 percentage points. The reduction of urban pretransfer poor families under ISP would be about 49% compared to a reduction of 21% by present programs, or a net decrease of 28 percentage points. (Estimates are from the Urban Institute's TRIM model [Bergsman et al., Koenig, Moeller].)

Concluding Remarks

In summary, a universal income maintenance program like ISP would substantially benefit the poor. Compared to present programs, it would raise twice as many pretransfer poor above the poverty line and would substantially close the poverty gap. While the disincentive effects are more difficult to estimate, it appears that there would be little slippage in ISP payments resulting from a decline in work effort.

A program like ISP would benefit the rural poor more than the urban poor. Compared to present programs, ISP would raise approximately 40% more of the rural poor above the poverty line, while raising only about 28% of the urban poor to nonpoverty status. This relative gain would not be because ISP favored the rural poor, but rather because it would correct inequities in current programs which are biased heavily against the rural poor population in the United States.

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The Impact of Income Maintenance Programs on Investment and Growth

Neal Walker and Luther G. Tweeten

Resources of the nation can be used to purchase either more total income or a more equal income distribution. Both equity (more equal income) and efficiency (more total income) are of value to society, but sacrifice of one may be required to gain more of the other. Society can make a better judgment of what is an optimal distribution of income if it is aware of the trade-offs between equity and efficiency.

This paper reports the impact of a broad range of income transfer programs (which ostensibly promote income equality) on investment and income, using 1960–69 as a study period.[1] The study rests on the proposition that long-run real income growth is a function of investment and aggregate supply in the Harrod-Domar tradition rather than by aggregate demand in the Keynesian tradition. Support for this proposition rests on apparently limitless wants of consumers in the long run and the widespread interpretation of the Keynesian model as relevant only to a short-run situation of excess production capacity (supply) and desire for liquidity as reflected in high *ex ante* savings intentions. Nevertheless, because lack of aggregate demand as well as aggregate investment and supply can limit short-run income growth, and because gross private domestic investment data used herein include some consumer durable investments which generate no future income streams, our estimates suggest the upper limit of the influence of income redistribution on income growth through investment. Steps involved in the analysis are: (*a*) to determine the distribution of social insurance benefits among income classes by sectors; (*b*) to determine the distribution of social insurance costs among income classes by sectors; and (*c*) to specify an investment function and combine the distributions obtained in steps (*a*) and (*b*) to determine the effects of income transfers on investment spending and income growth.

A simulation model was constructed to process the data and derive summary measures reflecting the effects of public transfer program expenditures. Input into the model included distributions among income classes of population, investment, consumption, and benefits and costs of public transfer expenditures. Output from the model included net transfer effects of program expenditures, investment effects, income growth, and summary measures of distributional inequalities.

The population, divided into urban, rural nonfarm, and farm sectors, was further divided into ten income classes (after taxes). Dollar amounts unless indicated otherwise (including income classifications) are reported in constant 1961 dollars below.

Three base years provided data to allocate benefits from social welfare programs and taxes necessary to pay for such programs. Data for base year 1961 were derived from the Survey of Consumer Expenditures (U.S. Dep. of Labor). Data for base years 1965 and 1966 were derived from the *Survey of Economic Opportunity* (U.S. Dep. of Commerce 1966–67). Distributions for the remaining years were linearly interpolated from base year data for the 1960–69 study period. The distribution of income was determined from *Statistical Abstract of the United States* (U.S. Dep. of Commerce 1961–70). Table 1 shows expenditures under social welfare programs considered in the study.[2]

Initially, income distributions by class and by sector were determined by the model. The first, posttransfer income, was the actual distribution of income including benefits from social welfare programs and the corresponding

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[1] Income redistribution also effects work incentives. Labor effects have received considerably more research attention than have investment effects and are considered by Bawden in this session. This paper disregards labor effects and concentrates on the impact of income transfers on income through intervening investment variables.

[2] Not included in the "social insurance" programs of this paper are farm commodity programs, which may be justified to hold a strategic reserve and stabilize prices but not to provide income transfers to the poor.

taxes supporting these programs. The second, pretransfer income, was the income distribution which would have occurred in the absence of income from social welfare expenditures and in the absence of taxes needed to pay for them. Pretransfer income plus income from investment of net transfers is referred to as simulated income. Simulated income is income which would have occurred in the absence of the social welfare programs shown in table 1.

Investment Functions

Investment schedules were developed from data from the U.S. Bureau of Labor Statistics.[3] Alternative investment schedules with higher marginal propensities to invest were tried but judged less realistic for the measure of investment used in this study, gross private domestic investment. Several adjustments were made in the income and investment data to estimate the return on net investment and growth of private income to individuals. Corporate profits (total) and inventory valuation adjustments were added to personal income, and dividends were subtracted to avoid double counting. To remove the influence of selected government investment, personal income was adjusted to reflect a 10% return on investment for schooling expenditures and a 50% return on investment for research expenditures.

A portion of the increase in aggregate personal income was due to growth in population and labor force. After making adjustments for the foregoing factors, an average annual return on investment of 50% was required to account for the growth in real income. It was assumed that investors receive a 15% return (before taxes) on their investments. The remaining 35% return on investment was distributed among income classes according to their consumption expenditures in accordance with the concept of consumer surplus. Investment to classes and sectors was cumulative over time.

Results

The model simulated investment and income annually for a ten-year period, 1960–69. The results are discussed below.

For all sectors combined, the break-even point in transfers of money due to social insurance expenditures occurred between the fifth and sixth income classes ($5,000) in all years. On the average, families earning below $5,000 per year received a net benefit from social insurance expenditures while families earning above $5,000 per year incurred a net cost from such expenditures. Of the classes receiving a net benefit, the lowest class ($1,000 and below) received both an increased

[3] Schedules of marginal investment rates by income classes for the population by economic sectors were used to determine the impact of income redistribution on income growth. Negative investment was common to each of the investment schedules in lower income levels and was accompanied by consumption levels which temporarily equaled or exceeded income. It can be argued that income transfers to low income groups (with high marginal investment rates) tend not to be spent on productive investment opportunities but rather are used to offset negative investment used for consumption purposes. Accordingly, in the simulation runs, marginal investment rates were considered zero where negative investment occurred. The rate of return on investment was assumed to be 15%.

Table 1. Expenditures under Selected Social Welfare Programs, (1961 $ Million)

Program	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
OASDHI	11,153	12,161	13,831	14,975	15,578	16,114	18,692	22,025	24,695	27,212
Railroad retirement	935	992	1,022	1,048	1,064	1,069	1,116	1,145	1,217	1,264
Railroad unemployment	217	213	161	120	89	73	48	35	40	37
Railroad disability	70	58	56	52	47	44	40	34	31	47
Public employment retirement	2,598	2,870	3,155	3,508	3,856	4,286	4,739	5,289	5,654	6,108
Unemployment	2,860	4,310	3,804	3,291	3,162	2,847	2,452	2,467	2,515	2,407
State temporary disability	347	382	403	435	463	458	467	475	493	528
Public assistance	4,145	4,441	4,877	5,148	5,365	5,957	6,724	7,920	9,528	10,773
Health and medical	4,390	4,757	3,261	3,315	3,456	3,656	4,007	3,988	4,220	4,212
Other welfare	1,174	1,248	1,602	1,719	1,864	1,956	2,159	2,605	2,828	3,127
Veterans pensions	3,464	3,690	3,733	3,582	3,869	3,940	4,075	4,043	4,051	4,050
Total	31,354	35,122	35,905	37,464	38,804	40,400	44,517	50,025	55,272	59,765

Source: U.S. Dep. of Commerce (1961–70).
Note: Expenditures are adjusted to constant 1961 dollars by the consumer price index.

absolute amount of transfer money and an increased percentage of total funds transferred over time. The highest income class ($15,000 and above) paid less into social insurance programs over time, both in dollar amounts and in the percentage of total transfers.

Transfers of money among the farm, rural nonfarm, and urban sectors decreased from $3,171.5 million in 1960 to $2,906.3 million in 1965, and then increased to $3,262.1 million in 1969. In percentage terms, transfers among sectors decreased throughout the study period from 10.12% of total expenditure in 1960 to 5.46% of total expenditures in 1969.

The urban sector experienced a net loss of transfers in each year. This loss tended to decrease through 1965 but then increased through the remaining years to a maximum loss of $3,262.1 million in 1969. The average annual loss to the urban sector was $3,110.2 million. The rural nonfarm sector realized a net gain throughout the study period. However, the net gain decreased yearly (except for 1961) from $3,171.5 million in 1960 to $2,556.6 million in 1969.

Though the farm sector suffered a net loss of money during the first three years, the position of the farm sector improved continuously throughout the ten-year period from a net loss of $147.4 million in 1960 to a net gain of $711.4 million in 1969. The rural nonfarm sector received 4%–5% of its total income from social insurance programs. While the farm sector was a contributor to social insurance programs in 1960, by 1969 the farm sector was even more dependent on such programs than was the rural nonfarm sector. In net, the urban sector essentially financed social insurance programs for all sectors throughout the ten-year period. Though urban losses due to transfers increased from 1965 through 1969, increases in total urban income more than compensated for transfer burdens. This allowed the urban sector to pay a declining percentage of its total pretransfer income into social insurance programs over time.

On a per capita basis, the burden of increasing social insurance programs fell almost entirely on upper middle income classes. Per capita costs in the $5,000–$6,000 income class increased by more than 300% during the study period, and per capita costs in the $6,000–$7,500 income class increased by more than 180%. In contrast, per capita costs in the highest income class were less in 1969 than in 1960.

Marginal investment rates were higher for upper income groups than for lower income groups in each sector; thus, income transfers from upper income classes to lower income classes decreased individual investment in all three sectors. The total investment decrease, $4.8 billion in 1969, was highly concentrated in the urban sector. Throughout the study period, the farm sector experienced heavier relative investment losses in proportion to sector income than did the urban and rural nonfarm sectors. This resulted from higher marginal investment schedules in the farm sector. Investment losses in the farm sector would have been even greater had the farm sector not received increased net transfers over time (see note 2).

Estimated income growth in the absence of social insurance programs is shown in table 2. During the study period, total posttransfer income increased by $204.7 billion. Had there been no social insurance transfers, income (simulated) would have increased by $226.9 billion. Thus, the income loss was $22.2 billion or 3.6% of actual 1969 income due to social insurance transfers.

In 1969, the lowest income class (below $1,000) had pretransfer income of $184.3 million; transfer payments to this class increased its income to $6.0 billion. In the absence of transfer programs, simulated income in the lowest class would have been only $1.1 billion. While this figure is many times the pretransfer income, it is less than 20% of posttransfer income. Measured by income, clearly the poorest were better off with social transfer programs than without them. All classes with income less than $4,000 per year benefited from the existence of social insurance programs.

The $4,000–$5,000 income class would have had about the same income in 1969 with or without transfer payments. For all classes above $5,000, simulated income exceeded posttransfer income in all years. Income in the higher classes would have been considerably greater in 1969 in the absence of social insurance programs. Simulated income for the highest class (above $15,000) was 12.8% greater than 1969 posttransfer income.

In terms of sectoral total income differences, more than 88% of the 1969 potential income gain (simulated income) occurred in the urban sector, 7% in the rural nonfarm sector, and 4% in the farm sector. The concentration of increased growth in the urban sec-

Table 2. Distribution of Income, (1961 $ Million)

Income Class	Posttransfer Income 1960	Posttransfer Income 1969	Pretransfer Income 1960	Pretransfer Income 1969	Simulated Income 1960	Simulated Income 1969
Below $1,000	1,135	5,981	376	184	376	1,140
$1,000–$2,000	9,932	17,150	2,946	6,406	2,946	7,724
$2,000–$3,000	19,378	21,789	14,085	13,879	14,085	14,933
$3,000–$4,000	30,405	22,888	27,402	20,224	27,402	21,124
$4,000–$5,000	44,919	31,005	44,313	29,899	44,313	31,054
$5,000–$6,000	51,852	46,325	52,164	47,452	52,164	48,942
$6,000–$7,500	75,498	82,336	77,035	86,501	77,035	89,251
$7,500–$10,000	84,041	130,981	87,941	135,688	87,941	140,838
$10,000–$15,000	54,041	162,964	57,328	172,589	57,328	177,202
Above $15,000	34,297	88,806	41,894	96,299	41,894	100,183
Total	405,491	610,230	405,488	610,224	405,488	632,373

tor resulted from the net loss of income through transfers which the urban sector experienced throughout the study period.

Summary and Concluding Comments

Although total expenditures in social insurance programs increased markedly from 1960 to 1969, they became less cost-effective in transferring money from the rich to the poor. Instead, most of the increased expenditures were transferred from upper middle income classes to lower middle income classes. This result stems largely from the changes in the composition of social insurance programs. Old age, survivors, disability, and health insurance (OASDHI) and public employee retirement accounted for 68.9% of the increase in expenditures during the study period. The costs and the benefits of these programs accrued mainly to the middle income classes.

The urban sector essentially financed social insurance programs throughout the study period. The rural nonfarm sector received a net gain in transfer funds throughout the period, but the gain decreased continuously. The farm sector improved its position throughout the period, going from a position of net transfer losses to one of net transfer gains.

The urban sector incurred greatest foregone income through decreased investment. Of the $22.2 billion total income loss due to social insurance programs, more than $19 billion occurred within the urban sector. Although national income was estimated to be reduced by as much as 3.6% due to income transfers, the benefits of income redistribution should not be overlooked. In the absence of social insurance programs, income classes below $4000 would have had only 66% of the income they actually received in 1969.

Public assistance payments are the only major program with substantial redistributional effects over a wide spectrum of income. For this reason, they entail greatest cost in foregone income—reducing 1969 income by 2.7% compared to 3.6% for all social welfare programs listed in table 1. Several proposed income maintenance programs would entail additional outlays equal to approximately half of public assistance outlays. Assuming proposed programs would have redistributional patterns among income classes similar to public assistance, we conclude that such programs would reduce total income by approximately 1.3% through the investment effect.

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Effectiveness of Public Income Redistributive Programs on Lower Income Groups

Sylvia Lane

The effects of income redistribution programs on the increase in capital and economic growth have been discussed previously. The concern herein is with (*a*) the effectiveness of income redistributive public policies and programs, mainly transfer and tax programs, in redistributing income; (*b*) why income distribution in the United States has remained virtually unchanged since 1947; and (*c*) proposed governmental income redistributive programs intended to benefit lower income groups.

The Relative Constancy of the Distribution since 1947

From 1913, the first year for which reliable data on the shares of income received by various income groups became available, the trend toward a more even distribution of family income in the United States extended through the 1920s, the 1930s, and the 1940s (Miller, pp. 46–50). "The increasing misery of the masses" predicted by Marx (Bronfenbrenner, p. 5) was not, and still is not, in evidence. However, as data in table 1 indicate, family income distribution in the United States in 1972 had changed little from family income distribution in 1947. The remarkable constancy of the percentage shares for each quintile of the before-tax family income distribution over this period is apparent.[1] Concomitantly, as income has increased, the gap between the lowest quintile and the highest quintile has widened.[2]

Reynolds and Smolensky provide further evidence of the persistent stickiness of the distributive shares for household income since 1950. Allocating all government taxes and expenditures across household income categories and using sets of normal, progressive, and regressive incidence assumptions, they estimated the size distribution of final income—income including government services—in 1950, 1961, and 1970. Gini coefficients revealed no significant differences among the distributions for household income for the three years compared (1975, pp. 9–24). Contrariwise, data on individual earned income, as opposed to family or household (total) income data, suggest a gradual trend toward inequality over the period since 1947 (Williamson, p. 1).

Williamson ascribed the difference in trends between household income and individual earned income to "the enormous increase in government transfer payments since the 1940's" (p. 2). The findings of Reynolds and Smolensky (1975, p. 14) indicate public transfer payments led all other estimated sources of absolute decline in inequality in household final income (table 2). According to another estimate, net fiscal incidence of all government taxes and expenditures during 1970 more than doubled final income of households initially in the under-$2,000 class while reducing the final income of households in the over-$25,000 class by 32% (Reynolds and Smolensky 1974, p. 516). Public transfer payments were estimated to be 55.3% of the income (essentially money income) for the 26.8% of the families with annual incomes of less than $3,000 in 1970 (Okner, p. 13).

Okun concluded federal taxes, as a whole, in 1972 were essentially proportional over the bottom 95% of families on the income scale.

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[1] Family income distribution is a representative measure of majority economic welfare since approximately 90% of the population lives in families. "Family income" is the total received by two or more people residing in the same household related by blood, marriage, or adoption. A household consists of all persons, related and unrelated, residing in the same housing unit (U.S. Dep. of Commerce 1975, p. 163).

[2] The gap in constant 1972 dollars was $6,264 in 1947 and $12,148 in 1972 (U.S. Dep. of Commerce 1974, p. 384).

Table 1. Percent of Aggregate Income Received by Each Fifth and Highest 5% of Families, 1947–72

Item and Income Rank	1947	1950	1955	1960	1965	1969	1970	1971	1972
Families	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lowest fifth	5.1	4.5	4.8	4.8	5.2	5.6	5.4	5.5	5.4
Second fifth	11.8	11.9	12.2	12.2	12.2	12.3	12.2	12.0	11.9
Middle fifth	16.7	17.4	17.7	17.8	17.8	17.7	17.6	17.6	17.5
Fourth fifth	23.2	23.6	23.4	24.0	23.9	23.7	23.8	23.8	23.9
Highest fifth	43.3	42.7	41.8	41.3	40.9	40.6	40.9	41.1	41.4
Highest 5%	17.5	17.3	16.8	15.9	15.5	15.6	15.6	15.7	15.9

Source: U.S. Dep. of Commerce (1974, p. 384).

Table 2. Sources of Absolute Declines in Inequality, 1950, 1961, and 1970

	(Decline in Gini Coefficients × 1,000)[a]		
	1950	1961	1970
Decline due to transfer payments[b]	18	32	51
Decline due to other specific expenditures	25	14	20
Decline due to all taxes (normal incidence)	21	12	7
Subtotal	64	58	78
Decline due to general expenditures	15	30	32
Total decline in Gini coefficient	79	88	110

Source: Reynolds and Smolensky 1975.
[a] Gini coefficients measure the degree of inequality in income (net national product).
[b] Transfer payments consist of social security, unemployment compensation, public assistance, and other cash transfers.

Progressive personal and somewhat progressive corporate income taxes were offset by regressive excise taxes and the payroll tax (p. 103). Barlow found even the federal income tax to be regressive for the lowest 10% in the income distribution over a five-year period (1967–71) (p. 223). For the upper 5% of families, however, personal and corporate income taxes have a heavy incidence and make the federal tax structure significantly progressive. When before-tax incomes were calculated so as to include items treated preferentially under the tax laws, federal personal income taxes in 1972, on the average, amounted to 11% of incomes for all taxpayers in the United States. Federal income taxes were 27% of income for families with before-tax incomes above $50,000, roughly the top 1% on the scale (Okun, p. 103).

Pechman and Okner, basing on their analyses of 1966 data, wrote "regardless of the incidence assumptions, the [overall] tax system is virtually proportional for the vast majority of families in the United States. Under the most progressive set of assumptions examined in this study . . . , taxes reduce income inequality by less than 5 percent; under the least progressive assumptions . . . , income inequality is reduced by only 0.25 percent" (p. 64). The limited progressivity of the federal tax system, increased to some extent by the individual income tax revisions of 1969 and 1971 (U.S. Congress 1973, p. 154), is offset by the regressivity of state and local tax systems.

Reasons Family Income Distribution Has Remained Unchanged since 1947

Basically, family income distribution has remained unchanged since 1947 for three reasons. Our tax system does not significantly decrease the share of the highest income quintile; transfers intended to benefit the disadvantaged, although effective, have not been sufficient nor distributed so that they would significantly increase the share of the lowest quintile; and, most important, there is now a higher proportion of persons in the categories that are constrained to low incomes in our society, i.e., the aged, female heads of family, and young families with relatively low earnings (U.S. Dep. of Commerce 1974, pp. 31, 38, 43).[3]

[3] Rivlin found an increase in the number of low income units between 1950 and 1973 because of "the increased tendency of adults of all ages to head their own households. Young people move out of the parental household sooner than they used to, old people are less likely to live with their children, and women—especially black women—are more likely to be family heads than they were a couple of decades ago" (pp. 9–10).

The level of governmental transfer payments to the disadvantaged deserves further comment. The two major public transfer payment efforts designed to supplement income for the disadvantaged are social security and public aid programs. Packer found annual payments to families receiving income from social security or welfare payments averaged $1,850 and $1,590, respectively, for families in the lowest quintile in 1970 (p. 100).

The 1972 Current Population Survey revealed only 36% of "poor" families (families below the federal low income threshold which was $4,275 per annum for a family of four in 1972) and 18% of "poor" unrelated individuals (individuals with a low income threshold of $2,019 per annun in 1972) received any public assistance cash at all (U.S. Congress 1974, p. 57).[4] For the "poor" who did receive transfer payments, the payments were most effective in lifting the aged above the low income threshold. Fifty-seven percent of the households with aged heads in 1971 were lifted above the poverty level by transfer payments defined to include private transfers and food stamps. Less than 40% of all other categories of "pretransfer poor" were lifted above the low income threshold by similarly defined transfer payments (U.S. Congress 1974, p. 53).

If the objective of the programs is income redistribution for the benefit of the "poor," then the current distribution of payments under transfer programs to aid the disadvantaged poses more of a problem than the level of payments. Approximately one-fourth of dollar outlays under federal income-security transfer programs in fiscal year 1972 accrued to beneficiaries under income-tested programs, i.e., programs basing benefits on needs of recipients (Packer, p. 108), but not all recipients of transfer payments under income-tested programs are in the lowest quintile of the income distribution. These programs are designed to aid separable categories of the disadvantaged, mainly the aged, the blind, the disabled, and children in female-headed families. The various income-tested programs permit different deductions from money income in determining income eligibility, allowing recipients under some programs to meet "need" criteria even though they are in higher income quintiles.

[4] The upper limit of the lowest quintile in the family income distribution in 1972 was $5,612 (U.S. Dep. of Commerce 1974, p. 384); "poor" families were 66% of the families in the lowest quintile. The upper limit of the lowest quintile in the income distribution in 1972 for unrelated individuals was $1,596. All unrelated individuals in the lowest quintile were classified as "poor." In addition, 44% of the unrelated individuals classified as "poor" were in the second quintile. Some of these were ineligible; some lacked information about available assistance; some were not referred to sources of available assistance; and some were reluctant to apply. These are not mutually exclusive categories.

Paucity of Resources and Opportunities among Members of Lowest Quintile

Shares of wage and salary and business and property income of the lowest and highest quintiles are in marked contrast (Upton and Lyons, p. 18), but this might not be a matter of widespread concern if, for the most part, members of the lowest quintile were single and without family responsibilities, young, educated, and if the burdens borne by those in poverty were not affecting children. But such is not the case. Approximately 14 million children under eighteen were members of lowest income quintile families in 1972 (U.S. Dep. of Commerce 1975, p. 16). Packer estimated 93% of all persons in the lowest quintile were members of families. Thirty-five percent of the heads of these families were aged. Only 24% of the men aged 65 and over were in the labor force in 1972 (Rivlin, p. 9). Twenty-nine percent of the heads of these families were female. Twenty-two percent of the family heads worked full-time. Forty-five percent of the family heads did not work at all (Packer, p. 97).[5]

Persons in the lower quintile are also lacking in the human capital resources associated with higher earnings. Forty-six percent of low income family heads (the federal interagency "low-income" level for families in 1972 was 76% of the upper limit of the lowest quintile in the income distribution) had completed less than one year of high school in 1972 (U.S. Dep. of Commerce 1973, p. 6). A preponderance of the members of the lowest quintile are persons with those characteristics that confine them to groups with the fewest employment opportunities and the lowest paid jobs or with the characteristics of those not in the labor force (U.S. Dep. of Commerce 1975, pp. 1–11).

Moreover, Budd estimated the lowest quintile had less than 0.5% of the total wealth in the United States in 1962 (p. xxii) and only 25% of those in the lowest quintile received

[5] The categories sum to over 100% because they are not mutually exclusive.

any income from dividends, interest, rents, estates or trusts, or royalties in 1970 (Packer, p. 100). The average family in the lowest quintile had $3,000 in annual money income in 1970 (Packer, p. 97). This low level of income is the combined effect of low earnings per worker and fewer employed workers per family, the level and distribution of transfer payments, and the distribution of wealth.

Proposed Income Redistributive Programs

The United States has no national statement of redistributive goals. Instead we have an assorted mixture of programs which reflect a rather nebulous set of tendencies toward income redistribution. Proposals for change in existing programs or for new programs to achieve a more equitable redistribution of income remain variations of those offered in the last twenty-five years. They generally involve changes in transfers (e.g., the negative income tax, reformulation of welfare programs) and taxes; increases in the investment in human capital, increases in employment opportunities, changes in the structure of the economy through legislation affecting private sector shares or by broadening the public sector, or some combination of these. The complete income redistributive effects, including the effect on labor supply, of measures already enacted under each of the categories discussed have yet to be estimated definitively.[6] The most notable recent decrease in the numbers of the low income population (those classified as being in poverty) occurred between 1958 and 1969 (Okun, p. 117), years in which employment, earnings, transfer payments, and non-cash-payment-great-society programs to help low income people all increased. But there is no agreement on the importance of each factor in the decrease.

Nonetheless, all of the proposals mentioned, appropriately formulated and properly targeted, would benefit some lowest quintile groups to some extent. Available estimates seem to indicate that even though, from a microeconomic stance, there is no such thing as a free lunch, especially in the short run, reslicing the pie judiciously using transfers, training and employment programs, community development programs, and full-employment policies to increase the income share of the lowest quintile would result, from a macroeconomic stance, in a larger pie in the long run.

[6] Theoretically, paying workers more than their marginal value product might cause some misallocation of labor and, increasing the level of transfer payments might lead to less labor being supplied, but according to Rivlin there is no persuasive empirical evidence in support of either of these contentions (pp. 6–7).

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Abstracts

Contributed Papers

Group I: Farm Management (Frank Orazem, Kansas State University, Chairman)

"Potential for Increased Net Income on Small Farms in Appalachian Kentucky." Fred J. Stewart (NRED, ERS, USDA)
A linear programming model based on primary data is used to determine the potential for increased net incomes on limited resource farms, with full-time operators, and farm sales less than $5,000. Net income changes associated with adoption of improved technology, restricted capital use, and increased tobacco leasing are examined.

"Returns to On-Farm Storage of Winter Wheat in Montana." Al Brogan (Montana State University)
Farmers face a critical decision in attempting to determine whether a crop should be sold immediately or stored for later sale. Montana wheat farmers receive a return for storing winter wheat. The rate of return increases in autumn months, declines sharply in January, and then increases until May.

"An Economic Analysis of Harvesting Systems for Flue-Cured Tobacco." William D. Givan (CED, ERS, USDA) and Fred C. White (University of Georgia)
A regression model was used to measure labor requirements for various harvesting systems for flue-cured tobacco. Bulk barns, tying machines, and riding primers substantially reduce harvest labor requirements. Labor requirements were then combined with other costs to identify least-cost harvest systems for various acreages and wage rates.

"The Economies of Size Available with Four-Wheel Drive, 140 Horsepower, and Larger Tractors in the Eastern Washington Dryland Farming Area." Gordon E. Rodewald, Jr. (NEAD, USDA, Washington State University)
Large four-wheel drive tractors provide farm operators with an opportunity to realize economies. The speed, drawbar pull, and ease of operation of these four-wheel drive tractors provide potential economies of size in total labor required and size of operation with no additional implement expenditures.

"The Farmer Decision Process in Purchasing Supplies." Thomas F. Funk (University of Guelph)
This paper summarizes the results of research designed to investigate the nature of the farmer decision process in purchasing supplies. The hypothesized decision process model includes five major stages: problem recognition, search for information, evaluation of alternatives, the purchase decision, and postpurchase evaluation.

"Hired Tobacco Harvest Work Force Characteristics in an Eight-County Area of North Carolina." Dale M. Hoover (North Carolina State University) and Leon B. Perkinson (EDD, ERS, USDA)
Development of a labor market study in a flue-cured tobacco production region in eastern North Carolina in response to probable rapid mechanization of the harvest is described. Preliminary analysis of the characteristics of individual workers and their potential for adjustment is presented. Needed and prospective analyses are also specified.

Group II: Food and Consumer Economics (Gorham Hussey, Armour Food Corp., Chairman)

"Effects of Reduced Birth Rates on U.S. Milk Consumption." Ronald A. Schrimper (North Carolina State University)
Reduced birth rates in the United States are estimated to account for nearly 40% of the 16.8-pound decrease in beverage milk consumption per capita between 1965 and 1972. Effects of continued low fertility rates over the next fifteen years on total beverage milk consumption are also projected.

"Household Purchase Response to Changes in Retail Milk Prices—Some New Evidence." William T. Boehm (Virginia Polytechnic Institute and State University)
Longer-run responses to changes in retail prices for most dairy products appear more elastic than short-run elasticity estimates imply. As costs of production increase, all policies which influence retail pricing should be reevaluated. In particular, the longer-run consequences of placing disproportionate increases on fluid milk prices should be examined.

"Consumer Attitudes toward Food Price Increases." Larry D. Jones, Loys L. Mather (University of Kentucky), and John Gibbs (Federal Land Bank of Louisville)
Consumers most frequently blamed government, food marketing agencies, inflation, and corporate profits for rising food prices. Solutions favored by consumers for slowing the rise in food prices included decreased government spending, export restrictions, and price controls. Age, sex, education, and income were found to most frequency influence consumer attitudes.

"A Systems Approach to Projecting per Capita Food Consumption." Allen G. Smith (ERS, USDA)
Per capita food consumption of twenty-four agricultural commodities are projected to 1985 using a three-component systems approach which accounts for price effects but is made internally consistent by constraining the model through aggregate price and production indexes.

"A Metademand Function?" Robert L. Thompson and G. Edward Schuh (Purdue University)
An analytical framework based upon recent developments in human capital theory, new household economics, and the allocation of time is proposed as a basis for long-run demand projections. Estimation of cross-country metademand functions, in which education and the opportunity cost of the housewife's time serve as shifters, is suggested.

Group III: Forest and Marine Economics (Lee Martin, University of Minnesota, Chairman)

"Present Volume, Growth, and Economic Value Predictions for Natural Timber Stands." Wallace E. Kilkreas and John E. Waldrop (Mississippi State University)
Owners of small natural timber stands can increase economic efficiency by using information similar to that available to owners of larger tracts. Multiple regression techniques were used to develop a system capable of providing such information. Inputs from these owners and/or private or public agencies are necessary for implementation.

"An Economic Analysis of the Case against *Ad Valorem* Property Taxation in Forestry." E.C. Pasour, Jr. and D. L. Holley (North Carolina State University)
Foresters have long argued that the *ad valorem* property tax is unjust as applied to forestry. These claims are examined and shown to be unfounded. In particular, a realistic example is used to illustrate both sides of the controversy concerning deferred yield bias, a controversy which is shown to be irrelevant.

"In Pursuit of Efficiency—A New Management System for the Forest Service." Lawrence W. Libby (Michigan State University)
There is pressure for more efficient management of public forests—broad exploitation of comparative advantage in producing timber and other outputs. Better documentation of opportunity costs of management choices will result from the new management system. Managers may resist apparent loss of discretion. Performance requires linking system to management incentives.

"Implementation of the 1974 Forest Service Planning Act—An Economist's Viewpoint." Paul F. O'Connell (Rocky Mountain Forest and Range Experiment Station, Tucson)
Implementation of the "Planning Act" as intended by Congress will require that a comprehensive demand analysis be incorporated into decision making on our national forests. In this analysis, outputs that relate to the public's demand must be identified for all investments to enable evaluation of agency performance.

"Optimum Allocation of Fishing Effort in the Gulf of Mexico Shrimp Fishery." Wade L. Griffin, John P. Nichols, and Ronald D. Lacewell (Texas A&M University)
When labor is paid on a shares basis rather than wages, all costs are not proportional to effort as is assumed in most fishery economic literature. In the case of the shrimp fishery, optimum effort would have been overestimated by 7,000 units and rent would have been overestimated by $30.4 million.

Group IV: Market Organization (Harry W. Ayer, University of Arizona, Chairman)

"Analysis of Market Structure and Performance in the Farm Supply Industry Using Simulation Techniques." E. M. Babb and L. A. Lumpkin (Purdue University, Land O'Lakes Cooperative)
The structure of the farm supply industry is projected to become more concentrated, but with about the current balance of cooperative and proprietary firms. Performance varied significantly among firms from different types of organizations and among different price levels. Farmers may face higher prices for inputs.

"An Institutional Approach to Vertical Coordination in Agriculture." Gerald R. Campbell and Thomas S. Clevenger (New Mexico State University)
Vertical coordination in agriculture is a complex problem. Coordination arrangements have both technical and organizational dimensions. This paper calls attention to the institutional dimensions of vertical coordination. It applies concepts of institutional economics to vertical coordination problems. Finally, the paper calls for an integration of economic techniques within an institutional framework as an approach to research on vertical coordination systems.

"Toward a Theory of Vertical Market Behavior." Dennis R. Henderson (Ohio State University)
The obliteration of previously distinct horizontal markets for agricultural commodities has focused increasing attention on vertical coordination in commodity subsectors. No accepted conceptual framework for analyzing vertical market processes exists. A subset of structure-conduct variables relevant to vertical market organization and behavior is suggested. Testable hypotheses are generated.

"Algorithms for Vertical Integration Indexes." Thomas L. Sporleder (Farmer Cooperative Service, USDA)
An index of subsector vertical integration is requis-

ite to empirically testing hypotheses concerning vertical integration. Two algorithms are suggested. The first algorithm is a crude temporal measure based on pricing points while the second is a more sophisticated vector index appropriate for both temporal and cross-sectional measurement.

"Theory of the Firm, Financial Considerations, and Structure in Agriculture: The Cattle Industry." Joseph C. Meisner (University of Missouri-Columbia)
Studies focusing on structural shifts in agriculture generally consider economies of size in production and/or marketing. Financial aspects need to be evaluated as agriculture becomes financed by equity from outside the firm. The cattle-feeding industry reflects structural shifts attributable to considerations of finance and risk management through taxation.

"Estimates of Optimal Grain Carryovers." Dan Sumner (University of Chicago)
Negative demand elasticities, storage costs, and random fluctuating production are incorporated empirically in a model developed and applied in calculating optimal world grain reserves. Results, under alternative specifications, including potential world cereal insurance programs and depending importantly on the restrictiveness of trade policies are presented for various countries and regions.

Group V: Economics of Livestock Production (Thomas W. Bell, Texas Tech University, Chairman)

"The Economics of Grain versus Harvested Roughage in Finishing Rations for Beef Cattle." Ray F. Brokken (ERS, USDA, Corvallis), T. M. Hammonds (Oregon State University), D. A. Dinius (Agricultural Research Service, USDA), and John Valpey (Oregon State University)
Presented is an economic analysis of grains versus roughages and the conceptual basis of experimentally derived input-output parameters. Feedlot profit functions featuring ration energy concentration as a key variable are formed by combining relationships for daily consumption of rations differing in nutrient concentration and daily energy requirements for growth.

"Beef and Other Enterprise Adjustments in the Southern Piedmont: A Consideration of Managerial Response to Changing Price Relationships." Neil R. Martin, Jr., James O. Wise, and Wesley N. Musser (CED, ERS, USDA, University of Georgia)
The role of managerial coordination with respect to response to price changes has increased in the 1970s. This paper presents a representative farm organization analysis with emphasis on price changes that have affected enterprises in the southern Piedmont. Correct price expectations yield substantially higher profits and fewer beef animals.

"Modelling the Forage-to-Beef Enterprises." Gerald D. Schwab (Michigan State University), John E. Kadlec, and David C. Petritz (Purdue University)
Forage and beef enterprises involve complex bioeconomic interactions. To provide decision-making assistance, a computerized model was conceptualized and developed to economically evaluate alternative beef-forage enterprises. With the cooperation of multidisciplinary personnel, the model was designed with sufficient flexibility to analyze a multitude of alternative farm resource and price situations.

"Analysis of Alternatives Available to the Midwestern Cattle Feeder." Mark Linder (Iowa State University)
Cattle feeding in the Midwest requires close analysis of alternatives available. Linear programming was used to determine the profitability of eight cattle-feeding systems. Scheduling of purchases and sales, feeding calves versus yearlings, and capital and labor availability all play important roles in the profitability of cattle feeding.

"Projecting Dairy Farm Livestock Inventories." Sherrill B. Nott (Michigan State University) and Frank J. Sargent (North Carolina State University)
A recursive, deterministic growth model for dairy livestock inventories is described. Milk cows, two replacement age groups, and culls are calculated. Exogenous variables are starting inventories, purchases, calving interval, heifer freshening age, and death losses. Illustrated model use includes interaction of cull rate with death losses and expansion analysis.

"Growth and Development of the U.S. Artificial Breeding Industry with Some Policy Implications." John W. Wysong (University of Maryland)
Major development of the commercial artificial breeding industry in the United States has occurred as the use of traditional breeding technology has declined in importance. A major future concern within the industry will be the impact of continued reduction in firm numbers and growth of individual firm size and scale on competitive forces within the total domestic and foreign artificial breeding market. The interaction of adjustments between the farm input supply sector and the farm production sector of the agricultural economy is expected to continue in the future as dairy farms become larger but fewer in number and more beef cow farms adopt artificial breeding. By 1985, additional realignment and restructuring of the industry can be expected as the farmer cooperative types of firms continue to merge and consolidate operations to gain the advantages of serving larger markets.

Group VI: Exports—Effects of Controls (Wallace C. Dunham, University of Maine, Chairman)

"Food Export Controls." Ruben D. Nunez and John R. Moore (University of Maryland)

Different types of export controls have different effects on domestic and world prices, as well as on the quantities produced and exported. There are alternative measures to avoid having to impose food export controls. The measures discussed here include global stocks and expanded food production.

"Nontariff Measures in the Short Run and Long Run." V. V. Sharma (Ohio State University)
Use of quantitative restrictions is increasingly advocated by developed and developing countries, and there is a likelihood of increasing restrictions on free trade. While there exists a possibility of some short-run benefits to domestic consumers, in the long run protective measures would reduce the welfare of consumers at home and abroad.

"The Effect of an Exchange Rate Change on Commodity Trade." William E. Kost (FDCD, ERS, USDA)
The theoretical effects of a devaluation or revaluation upon a commodity are evaluated. Devaluation will have only a small impact on agricultural trade (primarily a price rather than a quantity effect). Therefore, one cannot necessarily look to the agricultural sector for the major contribution to improving balance of payments disequilibrium.

"The Impact of Currency Realignment on U.S. Wheat Export Demand." Stanley M. Fletcher and Richard E. Just (Oklahoma State University)
This paper empirically evaluates three possible explanations for recent upsurges in U.S. wheat price and exports: currency realignment, world production shortfalls, and rising world affluency. This is done by developing an econometric model for U.S. wheat demand which is sufficiently disaggregated in the export sector to include important exchange rates.

"The Effect of EEC's Common Agricultural Policy on U.S. Farm Exports: An Empirical Estimate." Emilio Pagoulatos (University of Missouri-St. Louis)
An econometric model, consisting of estimated Common Market import demand equations for seventeen temperate zone agricultural products from the United States is utilized to provide a quantitative estimate of the static welfare loss incurred by the United States as a result of the implementation of the Common Agricultural Policy.

Group VII: Macroeffects of Changing Energy Prices (F. Larry Leistritz, North Dakota State University, Chairman)

"Simulations of the National Economy with Alternative Energy Availabilities." B. A. McCarl (Purdue University), J. B. Penn, G. D. Irwin (ERS, USDA, North Carolina State University), and L. Brink (Purdue University)
The recent energy situation has underscored the need for treating system interdependence in economic analyses. The national input-output tableau is incorporated into a constrained optimizing framework to treat direct and indirect effects of primary resource (energy) constraints. Results of alternative energy scenarios are presented for illustration.

"Potential Impacts of Energy Price Changes on Consumer Food Costs." Chinkook Lee, Norman K. Whittlesey, and Richard C. Shane (Washington State University)
This paper documents actual energy inputs for selected agricultural products for all activities from production to home consumption. It then estimates the potential food cost impacts of several alternative energy-pricing schemes. The findings of this analysis indicate that modest energy price changes are unlikely to have significant impacts on food costs, contrary to some beliefs.

"The Effects of Alternative Natural Gas Pricing Policies on the Market for Anhydrous Ammonia Fertilizer." Hal W. Everett and Otto C. Doering, III (Purdue University)
An econometric analysis of anhydrous ammonia supply and demand is made in the context of policy alternatives to maintain natural gas input for fertilizer. Results indicate a weak relationship between natural gas prices and fertilizer prices and availability.

"Energy and Agriculture: Hypothetical Export Unit Values for Crop Production Compared with Synthetic Fuel Production to 2020." Marc Messing and Susan D. Tripp (Environmental Policy Institute and Economic Research Service, USDA)
Given conflict over uses of water resources in the western states, quantification of hypothetical export values for synthetic fuels and crop production per unit of water in year 2020 is presented. Total water demands for the competing productions are derived. Results show crop production cannot compete economically with synthetic fuel production for water resources.

"Learning, External Benefits, and Methane Generation from Agricultural Wastes." Cleve E. Willis (University of Massachusetts)
External benefits from learning by doing exist for methane generation from agricultural wastes. Under a variety of circumstances, these external benefits exceed in magnitude the program costs necessary to induce the experience necessary to make such generation a viable activity.

"Selected National Economic and Energy Policy Impacts on the Texas Economy: An Input-Output Simulation Model Analysis." Milton L. Holloway, Herbert W. Grubb, and W. Larry Grossman (Management Science Section, Division of Planning Coordination, Office of the Governor of Texas)

A simulation model of the Texas economy was developed to analyze energy policy. An analysis of President Ford's proposals indicate a positive net effect of the excise tax and rebate program in the first year but large negative effects in later years.

Group VIII: Water Resources (William C. Nelson, North Dakota State University, Chairman)

"Water Resource Development Related Social Overhead Capital Expenditures in the Columbia Basin, 1950–70." C. W. Corssmit and P. B. Barkley (Washington State University)
Empirical Social Overhead Capital (SOC) data were collected and analyzed. SOC costs amount to 40% of primary costs and are substantially financed by state and county governments and semipublic utilities. Magnitude and incidence of SOC expenditures warrant study before commitment of public funds in irrigation development projects.

"Evaluation of the Garrison Diversion Benefit-Cost Ratio." Thomas Evensvold (North Dakota State University)
The size and validity of benefit-cost ratios depend, among other things, on the discount rate used and being able to measure social costs and benefits. The higher the discount rate, the lower the benefit-cost ratio. Consideration of social costs and benefits may affect decisions related to public investment.

"River Basin Simulation: An Interactive Engineering-Economic Approach to Operational Policy Evaluation." Clyde Kiker (University of Florida)
Management of water resource facilities requires consideration of multiple objectives. Hydrologic models in conjunction with interactive engineering-economic models provide detailed information for policy evaluation. Consideration of equity and efficiency of alternative policies is possible. Trade-offs of benefits and costs are elaborated.

"Flood Plain Management: A Need for More Positive Action." John G. McNeely and Ronald D. Lacewell (Texas A&M University)
Federal policy emphasizing flood control structures and financial relief to flood victims brought increased development and flood damages in flood plains. An overview of supporters of flood protection structures and the role assumed by the federal government is discussed along with recommended management policies for judicious flood plain use.

"An Economic Perspective on the Federal Flood Insurance Program." Leonard A. Shabman (Virginia Polytechnic Institute and State University)
Public policy toward flooding has focused upon minimizing flood damages, rather than correcting for market failures which can lead to nonoptimal use of flood plain land. This focus makes the current federal flood insurance program a serious obstacle to finding the optimum use of flood plain land.

Group IX: Pricing Issues (B. V. Lessley, University of Maryland, Chairman)

"A Methodology for Commodity Price Forecasting." Walter M. Myers (Connell Rice and Sugar Co.)
A methodology or procedure that has proven useful over the years in developing price models that can be applied to decision making is: to define a specific "real world" problem of importance before undertaking the analysis; to gain an understanding of the economic mechanism which generated the problem and influences its solution; to acquire a knowledge of the underlying time varying properties of the series itself; to select the minimum number of parameters and data transformation necessary for describing the situation; to statistically test and empirically evaluate the estimating performance of the model; and to develop decision rules for evaluating probable solutions and assume responsibility for implementing results.

"Reporting Cash Grain Prices: Issues and Their Possible Resolution." Bruce H. Wright and Randall E. Torgerson (USDA)
Continuing decentralization in grain marketing makes price reporting increasingly difficult. Modern transportation pricing methods cause grain at a central market to be less homogenous which further complicates price reporting. Problems encountered in collecting, reporting, and disseminating price information are discussed after the need for a market report is justified.

"Estimating the Structure of Time Lags between Wholesale and Farm Prices for Cottonseed." M. Dean Ethridge (University of Georgia)
A polynomial distributed lag model is used to estimate response of cottonseed prices to wholesale values of cottonseed products. Results indicate that wholesale values during the previous four months have most impact on cottonseed price in a current month. Implications for farm-to-wholesale price spreads since August 1972 are explored.

"Empirical Contributions to Basis Theory: The Case for Citrus Futures." Frank Dasse and Ronald W. Ward (University of Florida)
A futures basis should reflect the marginal cost of physical product plus a risk premium less a convenience yield. In addition, unique market characteristics may lead to basis biasness not explained by the storage theory. The basis for frozen concentrate is studied in order to show a measure of convenience yield along with a freeze and crop expectation bias.

"Price Spreads for Beef." Tom Sells (University of Idaho)
Farm-retail price spreads for beef have increased dramatically in recent years. The increased marketing margin adversely affects both the consumer and producer. This has caused much criticism to be

levied against the marketing chain, especially retailers.

"Impacts of the Cattle Cycle upon Beef Prices." Phillip L. Knox (Colorado State University)
A historical analysis of the four most recent cattle cycles was performed. Cattle inventories, beef production, and beef and cattle prices all exhibited significant cyclical variations. Farm-retail marketing margins, by-product values, and cattle feed prices all exhibit cyclical trends caused by the cattle cycle.

Group X: Agricultural Policy (Seeley G. Lodwick, American Farm Bureau Federation, Chairman)

"Explanation and Use of an Agricultural Policy Simulator (POLYSIM)." Daryll E. Ray (Oklahoma State University) and Theo F. Moriak (CED, ERS, USDA)
Policy makers need information on available options and the likely impact of pursuing those options. To help provide more complete information, an agricultural policy simulator has been developed at Oklahoma State University and implemented in Washington, D.C. for analysis of alternative agricultural policy proposals and economic conditions.

"The Rationality of Economic Policy." Ralph Lattimore (Agriculture Canada), G. Edward Schuh, and Robert L. Thompson (Purdue University)
Behavior of economic policy and policy makers is an important but neglected component of economic activity. Results are presented from two studies of the Brazilian agricultural sector which suggest that the level of government intervention in trade policy can be explained with a limited set of economic variables.

"Determinants of Changes in Farm Earnings in Areas with High Dependency on Government Regulated Crops." Dale H. Carley (University of Georgia)
The effect of market conditions and agricultural policy on farm earnings in individual counties was estimated. Methods were developed to show the importance of acreages, price, weather, and costs on earnings. Similar methods could be applied to any area where government regulated crops or a few commodities dominate agricultural income.

"An Analysis of the Price Support Program for Peanuts." Frank N. Fleming and Fred C. White (University of Georgia)
This paper develops a model describing the peanut sector including edible demand and purchases from CCC for crushing and export purposes. These results were used to project production, consumption, and CCC costs. Additional production for 1975–80 will be equally divided between edible and export markets with CCC costs increasing slightly.

"Stabilization with a Deficiency Payment Program—Some Theoretical Considerations and Empirical Analysis from the Canadian Situation." Larry Martin and Donald MacLaren (University of Guelph)
Canada's approach to stabilization of the livestock industry differs from stabilization programs analyzed in recent economic literature. In theory, the Canadian approach results in net economic benefits to society. Empirical analysis of pork stabilization indicates the potential magnitude of net benefits and shows that alternative programs have different stabilizing characteristics.

Group XI: Research Methodology in Demand, Supply, and Price Analysis (Harold C. Love, University of Alberta, Chairman)

"A Polynomial Distributed Lag Model of Pork Production Response." James N. Trapp (Michigan State University)
Specification procedures for polynomial lag models are discussed and demonstrated using pork data. Polynomially distributed lag estimates show the nature of response is different for various input and output price changes. Results of a polynomial and geometric model are briefly contrasted. Strengths and weaknesses of using polynomial models are summarized.

"An Analysis of the Monthly Prices for Farm Hogs in Georgia." Bill Floyd (University of Georgia)
Monthly hog prices in Georgia are affected by national and regional forces. National forces include monthly U.S. commercial hog slaughter, cold storage inventories of pork, and per capita income. Regional forces include the interaction between beef and pork supplies in Georgia and seasonal factors.

"Mathematics of Seasonal Price Behavior." Lloyd D. Teigen (ERS, USDA)
Differential equations were used to derive seasonal price patterns under two behavioral assumptions ("market conduct"). These were a competitive price rise equal to storage cost and the joint maximization of crop value plus storage profit. Compared with the competitive model, maximization virtually eliminates private storage and produces wider price fluctuations.

"The Estimation of Price Elasticities from Panel Data." Joseph Havlicek, Jr. and William T. Boehm (Virginia Polytechnic Institute and State University)
Statistical models and data sources play important roles in determining numerical estimates of price response. Price elasticities estimated from both time-series and cross-sectional viewpoints using the same data base yield results with quite different policy implications. Panel data permit model specifications which answer specific questions and should be used when possible.

"A Model for Estimating Supply versus Hectarage

Elasticities for Individual Crops." Morris D. Whitaker (Utah State University)
Supply response studies have generally approximated total supply response with hectarage elasticities. Farmers' response to changing relative prices, however, may involve use of yield-increasing factors as well as land. A model is developed for estimating the total supply elasticity that discriminates between hectarage and yield responses.

"The Use of Elasticities as a Tool in Measuring the Impact of Current Sugar Policy." Ralph D. Christy (Southern University)
The age of abundance has disappeared in the sugar market; so has the Sugar Act. This study estimates price and income elasticity for the period of recent price increases. Price and income elasticities were inelastic. However, price was significant in sugar consumption and should be considered in policy decisions.

Group XII: Risk and Uncertainty in Agricultural Production (Roger G. Johnson, North Dakota State University, Chairman)

"Adaptive Economic Systems and Firm Growth." W. H. Furtan, E. W. Kehrberg, and K. K. Klein (Purdue University)
The problem of uncertainty in farm planning remains unsolved. By using the concept of a production process, uncertainty can be modelled into the theory of the firm. An adaptive economic model can then solve the problem of resource allocation under uncertainty.

"Risk Transfer, Information, and Production Contracts: A Suggested Methodology." David Bessler (University of California-Davis) and Charles V. Moore (ERS, USDA)
Production contracts can be used to reduce or transfer risk but at a cost to the producer. The degree of risk transfer and its implicit cost can be determined using a Bayesian framework. The value of additional information is hypothesized as a function of the structure of the commodity market.

"Application of Expected Returns-Risk Criteria in Crop Planning." Lars Brink, K. K. Klein, and Bruce A. McCarl (Purdue University)
The Purdue Crop Budget is adapted to derive efficient frontiers for two expected returns-risk formulations: the minimization of total absolute deviations and the minimization of total negative deviations. The application refers to a typical crop farm, for which historical data are used to measure risk.

"Treatment of Stochastic Elements in an Aggregative Programming Model of Australian Agriculture." Neal Walker, Richard Monypenny, and Emilio Francisco (University of New England, Armidale, Australia)
Experimentation with methods of incorporating uncertainty in an aggregative programming model of Australian agriculture (APMAA) indicate that focus-loss constrained programming, while intuitively appealing, posed many quantification problems. Treatment of weather uncertainty through a rainfall-yield simulator and planning uncertainty through a stochastic LP formulation proved quite satisfactory.

Group XIII: Capital Accumulation and Firm Growth (Carl G. Anderson, Jr., Federal Reserve Bank of Dallas, Chairman)

"Capital Gains on Farm Assets by Value of Sales Class and by Farm Operators and Nonfarm Landlords, 1960–74." Carson D. Evans and Richard W. Simunek (ERS, USDA)
Capital gains on farm assets differ between kind, size of farm, and overtime. During 1960–74, farmland accounted for 85% of total capital gains; the smaller farms claimed at least equal share until the late 1960s. Approximately 70% of capital gains accrued to farm operators.

"Capital Gains in the U.S. Farming Sector, Nominal and Real, 1940–74." Emanuel Melichar and Marian Sayre (Board of Governors of the Federal Reserve System)
Knowledge of nominal and real capital gains improves understanding of trends in farm sector welfare. The series presented here can be readily updated for future current analyses. Real capital gains reached extraordinarily high levels in 1972–73, while the real capital loss in 1974 was the largest experienced during the period studied.

"Effect of Inflating Land Values on Ranch Growth Comparing Extensive Expansion and Irrigation Development Investments." Larry J. Held, Lynn H. Lutgen, and Glenn A. Helmers (University of Nebraska)
Fifteen-year financial simulation trials of a representative Nebraska ranch compared an extensive growth strategy against an irrigation expansion option. Constant and increasing land values were considered. Increasing land values enabled the extensive option to improve its relative net worth position compared to the higher income yielding irrigation option.

"Some Beneficiaries of Farmer's Capital Expenditures." Gerald E. Schluter (ERS, USDA) and Thomas A. Niles (American University)
An input-output analysis of farmer's capital expenditures which estimates the income and employment benefits accruing to sectors which directly and indirectly supply farm capital is used to provide one perspective on the economy-wide net effects of the capital for labor substitution process.

"A Model to Calculate the Cost of Capital for Farm Firms." John C. McKissick, Fred C. White, Wesley

N. Musser, and Bill R. Miller (University of Georgia)**
The cost of capital is an important input for financial decisions. The concepts of corporate cost of capital can be adapted to farm firms and information to calculate the cost of capital which can be derived from financial records. The aggregate cost of capital for Georgia farmers was 7.34%.

Group XIV: General Agricultural Economics (Gene A. Futrell, Iowa State University, Chairman)

"The Discount Rate: A Review of Opposing Viewpoints." Rajinder S. Bajwa (ERS, USDA)
Various criteria are advanced for selecting the discount rate most appropriate for analyzing public resource investment proposals, including opportunity cost, social time preference, and marginal equalization. Good arguments exist for using all criteria. The choice depends in each case on institutional and policy circumstances.

"A Social Psychological Approach to Government Welfare and Housing Programs." Barbara J. Redman (Iowa State University)
Social psychological balance theory concerning attitudinal consistency and change can yield implications of types of welfare programs for recipients' behavior. Attitudes toward welfare, charity, pride, income, and other goods are influential; the economic theory of choice is a submodel. The results support unconditional as opposed to matching-type grants.

"Internalizing Health Effects of Pesticides." Richard E. Howitt (University of California-Davis) and Charles V. Moore (ERS, USDA)
A survey of 1,416 California farm workers indicated significant under-reporting of pesticide injuries in official information sources. Institutions for internalization of externalities are operating inefficiently due to an imprecise data problem. Seventy percent of farm workers had never heard of Workman's Insurance and 20% could not understand pesticide warning labels.

"Linking Together the Production Function, Costs of Production, and Associated Optimality Conditions for the Upper Division Undergraduate and Beginning Graduate Student." Bruce R. Beattie and Wade L. Griffin (Texas A&M University)
The elementary algebra and geometry of the intimate relationship between the production function and cost curves and between the associated input and output optimality conditions, is developed for the single- and two-variable factor case. The presentation is intended to supplement a major deficiency of most textbook treatments.

"Economist Trade-Off: Can An Action Agency Economist Find Happiness in Academia?" Jack D. Edwards (Bureau of Land Management, Denver)
Experiences gained in a personnel exchange program between a land management agency and a land grant university are described and evaluated from the perspective of an agency economist. Professional activities within the university environment are contrasted with those in a government setting. Beneficial and adverse aspects of exchange are assessed in terms of exchangees, institutions, and students.

"A Location Quotient Simulated Input-Output Model for a Rapidly Expanding Economy." Charles L. Logsdon and Kenneth L. Casavant (Washington State University)
Regional trade between Washington and Alaska is substantial. Given Alaska's prospects for petroleum-based growth, a location-quotient simulated input-output model of the Alaskan economy was used to give a structural perspective of Alaskan industry and to project impacts on trade. The LQ model was inexpensive, fast, and did provide an initial picture of import needs.

Group XV: Using the Computer in Education (Norbert Dorow, North Dakota State University, Chairman)

"Five Years of Computer-Assisted Instruction: The Agricultural Economics Experience with Instructional Technology." John T. Whinnery and David E. Hahn (Ohio State University)
CAI has been a successful teaching technique for supplementing classroom presentations in introductory agricultural economics. Student attitudes favor CAI use and performance improves significantly, independent of the instructor. Multisectional courses have uniform content and extensive evaluation is possible. Course segments cover production principles and related cost concepts, investments, and elasticity.

"A Computerized Futures Market Simulation System." Steven C. Griffin and Paul D. Hummer (Oklahoma State University)
Classroom gaming can be used to reinforce theoretical and analytical concepts and provide experience in performing managerial functions. A computerized futures market game was developed to provide increased capacity and capability for executing sophisticated trading plans. A marketplace simulation model is used to provide market uncertainties and reduce data requirements.

"Computer-Assisted Testing (CAT)." Kelso L. Wessel (Ohio State University)
With larger classes, traditional examination and grading methods are no longer valid. Expanded educational use of computers is one solution. Computers can store, write, score, evaluate, and record examinations. Computer-assisted testing relieves the teacher of large classes of much mundane work and permits more time for innovative teaching.

"University of Illinois' Experience with an Interstate-Shared, Computer-Assisted Management

Program." Kenneth E. Stone and Duane E. Erickson (University of Illinois)
Computer-assisted management technology was introduced systematically to Illinois agriculture via an interstate-shared Touchtone terminal system called CAMPI. Introduction methods and results of user surveys are discussed. Interstate sharing allowed a shorter introduction period with a wider range of programs than would have been otherwise possible with available resources.

"An Extension Program in Family Financial Planning." W. A. Tinsley (Clemson University)
Recent, dramatic inflationary trends have upset family budgets. Clemson University extension workers have found an on-line computer budgeting program offered in shopping malls effective in establishing the rapport needed to cause families to better plan and control their personal finances. Traditional extension money management approaches have been less effective.

Group XVI: Population Mobility and Labor Availability (G. T. Dowdy, Tuskegee Institute, Chairman)

"Study of Employment in Agricultural and Agribusiness Occupations." J. H. Herbst (University of Illinois)
An employment study by a national committee of education, labor, and agriculture members used data from the Census of Population. Employment in occupations requiring agricultural competencies totaled 8,000,000, but should be adjusted upward by a million or more additional farm workers. Data are also presented by states.

"Income Distribution Consequences of Rural Industrialization." Jerry G. West and Roselee Maier (University of Missouri)
Income distribution consequences of various types of industrialization are examined. Extent of poverty, underemployment, and two measures of income inequality are used to assess the consequences of growth in employment in manufacturing, mining, and recreation. Mining appeared to have less impact on income distribution than the other industries.

"Retail Sales Retention and Migration in Rural Counties in the North Central Region." Marvin Julius (Iowa State University)
Retail consumption sales are a smaller proportion of consumption expenditures in more rural counties. The proportion tended to decline in all rural types during 1963–72. These tendencies were less evident in Missouri than in Minnesota and Iowa. Sales retention and variation from potential are shown for six county types.

"A Model for Predicting Sectoral Employment in Counties and Multicounty Areas." Wayne C. Curtis (Troy State University)
Continued emphasis on solving problems of economic development of rural areas necessitates expansion of existing techniques and development of new ones. Regression models to predict sectoral employment are developed for a rural county. Various combinations of independent variables are considered in developing each sectoral model, and policy implications are analyzed.

"Occupation Mobility: Implications for Effective Use of Rural Human Resources." Donald A. West and Stanley F. Hoppe (Washington State University)
Occupational mobility among farmworkers from 1965–70 was toward blue-collar jobs while the greatest growth in employment and highest levels of earnings were associated with white-collar occupations. Farmworkers may not be aware of the range of opportunities available to them which suggests the need for rural manpower services.

Group XVII: General Marketing (Truman Graf, University of Wisconsin, Chairman)

"Optimizing Subindustry Short-Run Marketing Organization: A Large-Scale Mathematical Programming Problem." Stephen W. Fuller (Texas A&M University), Paul H. Randolph (Iowa State University), and Darwin Klingman (University of Texas).
The paper relates optimum subindustry's organizational adjustment to decreased raw product output and new storage technology. The research product specifies existing processing plants to be activated and associated spatial and temporal raw product flows from production origins to activated plants at alternative sites. A solution was obtained by employing an out-of-kilter algorithm and implicit enumeration.

"Optimizing Retail Fertilizer Dealer Inventory Levels." Gary T. Devino and Lloyd A. Dever, Jr. (University of Missouri-Columbia)
The simulation model for inventory management which is described and illustrated provides a method for answering the business-planning needs of fertilizer retailers. Application of the model to a representative situation suggests adjustments which would reduce retail fertilizer dealer's inventory maintenance costs.

"Estimating Optimum Size of Dairy Plants Using Survivor Analysis." Sheldon W. Williams and James W. Gruebele (University of Illinois)
Survival analysis can be used to approximate optimum size in reasonably competitive industries but may reflect some lag in adjustment. The bounds of optimum size shown are influenced by all factors affecting plant operations. The analysis, based on limited, unsophisticated information can be used in situations where others are not feasible.

"Sources and Uses of Consumption and Sales Data for Market Monitoring and Marketing Evaluation

Purposes." Lyle Solverson (Southern Illinois University-Carbondale)
Consumption or sales data are valuable for market-monitoring and marketing evaluation purposes. Most published consumption data are not useful for these purposes because of the method of derivation. Milk sales are available on a monthly basis. In order to be useful, adjustments must be made for seasonality and calendar composition.

"Agricultural Commodity Projections: A Multimarket Equilibrium Approach." Gerald E. Plato (ERS, USDA)
A Walrasian tatonnement approach for projecting consistent equilibrium prices and quantities of agricultural commodities is described. The tatonnement market clearing process is simulated by a modified Newton-Raphson procedure after evaluating selected levels of exogenous market variables. Effects of specific exogenous variables can be simulated through judicious scenario selection.

Group XVIII: Agriculture and the Energy Crisis (John P. Walter, Shell Oil Co., Chairman)

"Energy Use for Irrigation in the Seventeen Western States." Dan Dvoskin, Ken Nicol, and Earl O. Heady (Center for Agricultural and Rural Development, Iowa State University)
Irrigation is a major consumer of energy in agricultural production accounting for 25% of all direct energy inputs. This paper outlines a systematic procedure to evaluate regional differences in irrigation energy use. An average of 1.56 million kilocalories are used per acre to irrigate cropland in the West.

"Direct Energy Use in Milk Production: Methodology and Coefficient." Gary G. Frank (CED, ERS, USDA)
Points of energy usage on dairy farms must be identified to assist in conservation and allocation. Procedure illustration includes an example farm and a discussion of the major uses of electricity. The fixed and variable energy needs of selected chores are quantified. Use is cataloged by type of energy.

"The Impact of Changing Energy Prices on Net Returns, Production Methods, and Kilocalories of Output for Representative Irrigated Farms." Vernon Eidman, Craig Dobbins, and Harold Schwartz (Oklahoma State University)
The model indicates certain reduced tillage methods are profitable at current prices and that the method used is stable for a 50% increase in fossil fuel prices. Employing these methods results in relatively greater increases in net returns and food calories produced than in the fossil fuel inputs used.

"Shifts in the Competitive Advantage of Traditional and Energy-Intensive Agriculture under Rising Energy Cost: The Case of Nicaragua." Philip F. Warnken (University of Missouri-Columbia)
Fossil-based agricultural input price increases have shifted the competitive advantage from energy-intensive agriculture to traditional agriculture in Nicaragua. A decline in output prices would make energy intensive agriculture uneconomical and reduce aggregate output of four major food crops, posing serious policy dilemmas for national development.

"Short-Run Corn-Soybean Production Decisions with Variable Energy and Product Prices." D. Lynn Forster and Norman Rask (Ohio State University)
Midwestern farmers have approached the past few planting seasons facing new input and output price levels. Optimum nitrogen fertilizer applications and corn-soybean product combinations are analyzed under alternative price assumptions for a typical Ohio farm. Nitrogen, corn, and soybean prices substantially affect optimum corn acreages.

"A Cost Analysis of Low-Temperature Grain Drying: A Comparison of Electric and Solar-Electric Corn-Drying Systems." Fred L. Hepler (Iowa State University)
Supplemental solar energy for low-temperature grain drying is technologically feasible. Electric drying costs are less per bushel in Iowa than comparable solar-electric systems. A sensitivity analysis of the price of electricity and efficiency of solar collectors does not change the results significantly, except with large increases in electricity prices.

Group XIX: Rural Community Services (John Thompson, South Dakota State University, Chairman)

"What National Policy Lessons Have We Learned in Rural Development?" Joseph D. Coffey (Virginia Polytechnic Institute and State University)
Fourteen lessons are drawn from the past six years of U.S. Department of Agriculture rural development activities. The overriding lesson is when we do not know what to do or how to do it and when the public is not demanding it be done, little progress will be made.

"Some Estimated Socioeconomic Impacts on a Rural Community Caused by a Private Utility: A Preliminary Study." Hilton P. Settle (Virginia Polytechnic Institute and State University)
A major hydroelectric facility has been proposed for construction in an isolated rural area of Virginia. Construction expenditures of $500,000,000 are anticipated over a seven-year period, with a peak construction work force of 2,400. Some of the major socioeconomic impacts are examined from a local accounting stance.

"A Decision-Making Framework for Municipal Ser-

vices in Rural Areas." Ron E. Shaffer and Jeff C. Stier (University of Wisconsin-Madison)
Municipal officials must make decisions concerning services without, the aid of traditional market mechanisms. Suggestions are made on how to overcome these shortcomings through the use of simulation techniques. The framework developed incorporates the influence of social, economic, spatial, and political components of the community on municipal service decisions.

"A Programming Model for Analysis of Nonmetropolitan Hospital Services Systems." Marvin R. Duncan (Iowa State University)
A linear programming application of economic planning for hospital services delivery is described. Readily available hospital and public source data are used. The model incorporates an interhospital service comparative advantage production sector, a transportation network, and a service demand sector. Policy change impacts on the system can be determined.

"The Effects of Property Taxes and Local Public Services upon Residential Property Values in Small Wisconsin Cities." Melville McMillan and Richard Carlson (University of Wisconsin)
Previous studies have resulted in conflicting evidence as to the degree of capitalization of fiscal factors in property values. Using ordinary least squares we found near full capitalization but no significant capitalization with two-stage least squares. This is an indication that the supply of residences in nonmetropolitan areas is highly elastic.

Group XX: Agriculture and Environment (Kenneth R. Krause, ERS, USDA, Chairman)

"Incommensurables, Trade-offs, and the Multiple Product Model: Why the Confusion?" Gary D. Lynne (University of Florida)
A multiple objective problem arises when the achievement levels of societal goals cannot be measured in a common unit. The conceptual basis for dealing with this problem in water resource development through trade-off calculations is discussed. It is concluded that the relevant trade-offs are really approximations of price ratios.

"Response to an Environmental Policy in the Agricultural Sector: An Interregional Analysis." Paul Fuglestad (ERS) and Anton D. Meister (Iowa State University)
A policy of comprehensive environmental enhancement in the agricultural sector will have implications for land and water use, production patterns, food costs, employment, and income. The effects of an assumed policy of restricted livestock waste disposal, reduced erosion, and enhanced wildlife habitat are analyzed using an interregional linear programming model.

"Environmental Impacts of Alternative Nitrogen Fertilizer Strategies." P. James Rathwell (Citrus Research Center, Texas A&I University) and Daniel D. Badger (Oklahoma State University)
Four nitrogen fertilizer strategies were analyzed for a fifteen-county wheat and grain sorghum region in north central Oklahoma and south central Kansas. The basis of analysis was an environmental impact matrix with three major parameters: economic, environmental quality, and social well-being. The maximum nitrogen strategy ranked highest.

"Social Costs of Alternative Policies to Control Air Pollution from Open Field Burning in Oregon." Jagjit S. Brar (Southeastern Louisiana University)
Decreases in consumers' surplus and Oregon industry rents for three policies to control pollution from open burning of grass seed residue in Oregon were estimated. Decreases in Oregon rents were directly related to elasticity of non-Oregon supplies. Gains in non-Oregon rents were only about 20% of losses in Oregon rents.

"Pest as a Common Resource: A Case Study in the Control of the Alfalfa Weevil." Uri Regev, Gershon Feder (University of California-Berkeley), and Andrew P. Gutierrez (University of California-Davis)
This paper analyzes some common property aspects of pest control problems which result from interseasonal migration. An economic optimization framework is offered to obtain and compare private and social pest control policies. An application to alfalfa weevil control problem yields optimal strategies and their policy implications are discussed.

Group XXI: Public Finance (Lowell D. Wood, Brigham Young University, Chairman)

"Benefits and Burdens of Government Fiscal Policy: A Study of the Distributional Impacts of Federal and State-Local Taxing and Spending." Joel C. Plath and Harry W. Ayer (University of Arizona)
The distribution of income among income classes is estimated for the United States and urban, rural, and farm populations of the West. New theory is then used to estimate the distribution of public goods benefits among income classes. Estimates of the distribution of taxes and specific goods benefits are also made.

"An Alternative Method of Assessing Preferences for Potential Government Goods." Ian W. Hardie and James E. Kirkley (University of Maryland)
Benefit-cost methods are usually used to solve the problem of choosing which goods a government agency should supply. Budget-oriented methods compare favorably with the benefit-oriented approach to solving this type of problem. One such technique which appears to be especially promising is the managerial simulation method.

"Alternative Approaches for Estimating Educational

Production Functions in Rural and Urban Areas." David L. Debertin (University of Kentucky)
Educational production functions using achievement scores and freshmen college grade point averages as output measures were estimated. Separate studies were conducted in North Dakota and Indiana high schools. Neither study found evidence of a relation between educational inputs and the output measures.

"The Determinants of County and City Expenditures for Community Services." Dilip Pendse (Virginia Polytechnic Institute and State University)
The composition of the determinants of expenditures for community services differ between the counties and cities as a whole and between the "predominantly white" and "racially mixed" communities. Separate regression equations should be fitted to the city and county expenditures for police protection, fire prevention, public health, and public works.

"Measuring Property Tax Incidence: A Maximum Likelihood Approach." H. Evan Drummond (Oklahoma State University)
Taxes on agricultural land may be capitalized into the value of the land or they may be shifted either forward or backward. An empirical investigation of the rate of capitalization using maximum likelihood procedures suggests that capitalization may not be as prevalent as expected. Recent changes merit further investigation.

Group XXII: Production Economics and Farm Management (LeRoy W. Schaffner, North Dakota State University, Chairman)

"Treatment Trigger for Pesticide Application: A Positive Approach." Hovav Talpaz and Raymond E. Frisbie (Texas A&M University)
Treatment trigger is an empirical economic, insect-caused-damage threshold coincident with the maximum net income. It is a dynamic measure which depends on the plant's age, insect-crop relationships, and the production physical-economic conditions. An estimation of the treatment trigger for the cotton fleahopper in Texas's Blackland is presented.

"The Development of a Corn Crop Response Model for an Economic Irrigation Scheduling Model." Thomas H. Morgan (Kansas State University)
A corn crop response model with water as the independent variable and grain yield as the dependent variable was developed and tested. The growth process was divided into a vegetative growth function and an ear development function. The exponential equation and a modified logistics equation were used in estimating the two functions.

"Returns to Information: Experimenting with Farmers." Robert J. Rades, Gerald A. Harrison (Purdue University), and David L. Debertin (University of Kentucky)
A computerized management game was used to estimate the returns to research information for corn and soybean producers. Experienced corn and soybean farmers made decisions in a laboratory environment. Results indicated significant positive returns to the research information.

"Elements of Successful Labor Management among Georgia Farmers." John W. Nixon, Fred C. White, and Bill R. Miller (University of Georgia)
A recent survey revealed growing shortages of hired farm labor in Georgia. Quantities available are very sensitive to competing wages, job security, public welfare programs, and noncash benefits offered. Successful management will require strategic use of family members, specialized labor hiring at opportunity-cost wages, and generous incentive compensation plans.

"Costs of Producing Sugarcane in Sao Paulo, Brazil: The Policy Implications." Harlan Hughes (University of Wisconsin-Madison) and Philip Warnken (University of Missouri-Columbia)
The objective was to provide the Institute for Sugar and Alcohol with an accurate estimate, an economic analysis, and the policy implications of the per ton costs of producing sugarcane. The long run implications of the 1968–69 data are that farm units will grow in size and reduce in numbers.

Group XXIII: International Development (Peter Dorner, University of Wisconsin, Chairman)

"Multiobjective Formulation and Evaluation of Public Investments in LDCs: A Goal-Programming Approach." Alfredo Sfeir-Younis and Daniel W. Bromley (University of Wisconsin-Madison)
The application of goal programming to multiobjective evaluation of investment strategies in less developed countries is demonstrated. Advantages over linear programming and simulation models for LDC governments are detailed. A numerical example provides an illustration of strengths of goal programming, particularly with respect to sensitivity analysis on various parameters.

"The Status of Cooperatives in the Imperfectly Competitive Grain Export Market." Michael J. Phillips (Farmer Cooperative Service, USDA)
The importance of U.S. grain exports to the world is requiring a better understanding of this industry. Examination of the industry shows that grain cooperatives are competing in a very imperfectly competitive market and are not in a competitive position.

"World Hunger and the Land Grant Universities: Constraints to Technical Assistance in International Agriculture." E. Boyd Wennergren and Morris D. Whitaker (Utah State University)

The land grant university system has the world's largest reservoir of quality agricultural scientists. Failure to legitimize technical assistance as a university mission and use of technical assistance as a tool of foreign policy are only two constraints which create significant disincentives and impede effective involvement of these scientists.

"Fertilizer Price Inflation: A Threat to the Green Revolution." Glenn C. W. Ames (University of Georgia)
The Green Revolution has provided developing countries with new agricultural potential and increased their dependency on adequate supplies of reasonably priced fertilizers. In Karnataka, India fertilizer prices have doubled and shortages have been reported. Cooperatives have not expanded their crop production loans to meet rising cost of modern inputs.

"The World Sugar Economy." Ahmed Abou-bakr and A. H. Harrington (Washington State University)
Aggregate world production and consumption trends lead periodically to drastic changes for the one-third of the sugar moving in world trade. The proportion traded has declined. Removal of protection would increase the world price, decrease the production in developed nations, and increase the exports of developing nations.

Group XXIV: Education: Extension, Resident Instruction (Raleigh Barlowe, Michigan State University, Chairman)

"Model-Assisted Planning for Extension Education Programs." Kenneth D. Duft (Washington State University)
This paper proposes that Model-Assisted Planning, a program planning system developed and tested by industry, be adapted by extension program administrators. The MAP system is schematically developed and an existing agribusiness management education program is used to illustrate how the adoption process might be facilitated.

"A Multimedia Approach to Agribusiness Management Education." K. W. Kepner (Purdue University)
Management training activities generally rely upon printed input materials. In reality, managers receive significant input from audio (telephone) and audiovisual (meeting) sources. Multimedia training emphasizes the same media input resources utilized by managers. Learner involvement-participation is enhanced and the realism of the educational experience is greatly improved.

"Land Use Planning Models: An Experiment in Interdisciplinary Education." Reuben N. Weisz (University of Arizona)
This paper describes an experiment in interdisciplinary education that focuses on quantitative land use planning techniques. Lectures introduce students to a variety of planning models. Through coordinated individual and team research, students develop alternative models that are applied to a relevant, local, real world, land use planning problem.

"An Assessment of Extension Educational Land Use Publications." Craig L. Infanger and A. Frank Bordeaux, Jr. (University of Kentucky)
Based on a review of existing materials, more effort should be made in extension publications to provide historical perspective (awareness education) to land use issues. Likewise, additional effort is needed in laying out policy alternatives. Synthesis and publication of existing information on consequences of land use controls is needed.

"Economics in Action: An Educational Experience for Youth." John E. Ikerd, D. G. Harwood, and R. D. Dahle (North Carolina State University)
Economics in Action is a short-term, high impact program designed to acquaint youth with the realities of their economic environment. It combines concepts from the economists and the real world of business and government leaders with the questioning minds of young people to achieve impressive educational results.

Group XXV: Analytical Models for Rural Development (George Rose, South Dakota State University, Chairman)

"Rural Development Needs and Policy—The University's Response." Earl D. Kellogg (University of Illinois-Urbana-Champaign)
Rural development policy must be broadened to accommodate changing conditions and diversity among rural areas. Part of this policy should include investment in developing appropriate technology and institutional innovations. Universities can respond by increasing the number of disciplines participating in rural development research, teaching, and extension efforts.

"A Model of Economic-Demographic Interaction in Development." Bruce A. McCarl, T. Kelley White, Frederick W. Obermiller, and David R. Martella (Purdue University)
The Purdue Development Model (PDM) provides a conceptual and operational structure for modeling agricultural economic development within a total systems framework. Interactions between economic and demographic change and the interdependence of agricultural, nonagricultural, and public sectors of an economy are explicitly recognized.

"The Economic Base Ratio as a Tool of Analysis for Cities and Counties." Arthur Culver Duarte (California Polytechnic State University)
Economic base ratios for cities, counties, and regions were computed using data on gross income,

number of firms, employment, and wages paid. Local economies arbitrarily separated into basic and service sectors. Base ratios found to be variable over time, differ among areas, and vary among data sources.

"Computer Mapping as a Tool in Applied Economics Research." David Mulkey, James C. Hite, and Agnes Sims (Clemson University)
Informed land use policy decisions and related research require vast quantities of information. Computer mapping offers a method for storing, manipulating, and retrieving data; thus, it can facilitate applied land-related research. CLUIS, the South Carolina computerized land use information system, is an example of computer application to land use problems.

"An Aggregate Model of Supply and Demand for Labor in the Coosa Valley Area of Georgia." Bill R. Miller and Peng Li Liu (University of Georgia)
An aggregate model of supply and demand for labor is presented for a subarea of Georgia. Results show that agriculture of the area is no longer a significant source of labor for industry even though labor returns in agriculture are not competitive with labor returns in other industry.

Group XXVI: Natural Resource and Industrial Development (Maurice E. Baker, University of Nebraska, Chairman)

"The Economic Impact of Rural Industrial Growth: A Critique of Empirical Studies and a Proposed Research Strategy." Eldon D. Smith (University of Kentucky)
Assessments of industrial development potentials of rural areas require evidence of probable impacts relevant to local decision makers and supporting agencies. A weakness of past research is its highly limited applicability to situations outside the study area. A regional approach using standardized techniques to measure impact and regression analysis to provide generalizability is suggested.

"Nebraska Irrigation Development and Its Effect on the Frenchman Valley and H & RW Irrigation District." Russell Fries (University of Nebraska)
This report discusses a situation where groundwater development has materially affected the base flow and subsequent irrigation capabilities of a surface stream. Three types of reasons are given for the cause of the problem: physical, economic, and legal. The legal reason is the underlying cause since there is no regulation of groundwater. Solutions are given for each of the types of causes with the ultimate solution the establishment of comprehensive water management legislation.

"Projecting Public Sector Effects of a New Industry in a Rural Area." F. Larry Leistritz, Arlen G. Leholm, and Thor A. Hertsgaard (North Dakota State University)
This paper presents a model for *ex ante* evaluation of the effect of new industry on public sector costs and revenues. The model employs input-output interdependence coefficients and cost and revenue estimators to evaluate total (direct, indirect, and induced) effects of new industry. Model application is demonstrated.

"Factors Influencing Manufacturing Employment Change in Small Wisconsin Cities: 1960–70." Robert Weaver and Melville McMillan (University of Wisconsin)
Community-determined factors influenced local manufacturing employment change and could be instrumental in determining local development policy if manufacturing continues to decentralize. While local taxes had only a minute effect, manufacturing employment appeared responsive to the quality of local public services. Interactions among variables proved important in many instances.

"Interindustry Allocation of Privately Owned Open Access Resources in the Coastal Zone." Jeff V. Conopask (Environmental Protection Agency) and Burl F. Long (Virginia Polytechnic Institute and State University)
Tidal wetlands provide many valuable services which are open access in nature. Their location in the population-intensive coastal zone results in a strong site demand for alteration to priced economic activities. A regional linear programming approach is offered as a planning tool to assist in allocation of this resource.

Group XXVII: Econometric Demand and Supply Analysis (Thomas Daves, South Dakota State University, Chairman)

"Implications of Natural Gas Shortage for Industrial Demand and the Environment." Wen S. Chern and Gurmukh S. Gill (Oak Ridge National Laboratory)
A model consisting of demand, price, and output equations was estimated by techniques of error components and two-stage least squares. Thirteen manufacturing industries were selected for analysis. Results show that the deregulation of gas prices should be an effective means of reducing both future gas shortage and environmental degradation.

"Effect of Alternative Product and Input Prices on Demand for Irrigation Water: Texas High Plains." Gary D. Condra and Ronald D. Lacewell (Texas A&M University)
The demand for irrigation water influences both the current levels of crop output and future life of irrigation on the Texas High Plains. This study estimates the effect of alternative crop and natural gas price levels on demand for water and associated crop output levels on the Texas High Plains.

"The Impact of Inflationary Pressures on the De-

mand for Beef." F. Steven Sanders (Oklahoma State University)
Previous demand models of the beef sector have failed to explain consumption patterns during inflationary periods. An expanded demand model is created using time-series data. The results suggest a strong substitution effect between beef consumption and the prices of nondiscretionary commodities as measured by the consumer price index.

"Simulating Farm Outputs, Prices, and Incomes under Alternative Sets of Demand and Supply Parameters." Chung-Jeh Yeh (ERS, USDA)
A two-equation aggregate demand and supply simulation model with geometrically distributed lags is used to examine the impacts of alternative demand and supply parameters on agricultural prices and quantities. Equilibrium solutions indicate that strong demand shifts are needed to maintain a favorable level of prices and farm incomes.

"Off-Farm Labor Supply and the Value of the Farm Operator's Time." T. F. Glover (Utah State University)
The purpose of this paper is to derive a common set of parameters which underlie the functions determining the probability that a farm operator works off the farm, his days of work, off-farm daily wage, and the shadow price of the operator's time.

Group XXVIII: Policy, Programs, and Returns to Research (Hugh L. Cook, University of Wisconsin, Chairman)

"A Policy Analysis Model for the Canadian Dairy Industry." Ram K. Sahi and David H. Harrington (Economics Branch, Agriculture Canada)
An econometric model for the Canadian dairy industry was developed to project production, consumption, trade, and prices of milk and milk products to 1980 under four dairy policy options. The options are: status quo, free market situation, and increase in producers' return from direct subsidy and from support prices.

"Pricing Milk by Economic Formula—The Virginia Experience." H. M. Harris (Virginia Polytechnic Institute and State University)
This paper traces the situation in Virginia that led to the adoption of an economic formula for pricing milk in July 1974 and summarizes an analysis of various economic formulas as alternative pricing mechanisms. Comparisons suggest the formula has boosted Virginia milk prices as much as $0.07 per half gallon above levels which would have been expected.

"Social Rate of Returns to Investment in Agricultural Research: Potato Storage in the United States." A. A. Araji and R. J. Miller (University of Idaho)
Increased competition for public funds and the rising criticisms of agricultural research make it imperative that the benefits of agricultural research to society be explicitly demonstrated. The extremely high rate of returns to potato storage research, explicitly demonstrated in this paper, highly justifies increased public support for agricultural research.

"The Contribution of Research and Extension to Agricultural Productivity Growth." Yao-Chi Lu (NEAD, ERS, USDA) and Philip L. Cline (Oklahoma State University)
The rate of return to public expenditures on research and extension aimed at increasing productivity at the farm level was estimated to be 22% for the 1939–72 period. It declined over time, from 25% for the 1939–48 period to 19.5% for the 1969–72 period.

"The New Congressional Budget Process and Implications for Agricultural Funding." Allen C. Grommet (Committee on the Budget, U.S. House of Representatives)
The 1974 Budget Act initiates significant changes in the congressional budget process. It specifies a timetable, establishes a policy priority review procedure, and places the budget in the general fiscal context with tax, deficit, and debt concerns. The changes will affect agricultural funding and may suggest some associated research.

"Product Life Cycles and the Adoption of Durable Inputs: An Example for the Tomato Harvester." Hoy F. Carman and Jon A. Brandt (University of California-Davis)
A theoretical framework is developed for product life cycles of durable inputs and then is empirically tested using the logistic growth function to explain mechanical tomato harvester adoption. Reasons for the rapid adoption of the mechanical harvester are offered; implications for new markets and replacement sales are discussed.

Group XXIX: Transportation Economics (Robert Tosterud, North Dakota State University, Chairman)

"Transportation in Rural America—Problems and Research Needs." Edward I. Reinsel (NEAD, ERS, USDA)
Rural transportation problems seem less acute than two years ago. Problems remain; extensive multidisciplinary research on major modes is suggested. Mobility problems of rural people and relationships between rural development and transportation require study. Forecasting of supply and demand for services is needed. Economic Research Service transportation research is outlined.

"To Regulate or Not To Regulate." Walter J. Wills (Southern Illinois University)
There is a growing clamor for railroad deregulation. The arguments suggest that competition will work, that regulation is costly and a failure. Only the naive could believe two or three firms provide effective competition. Vested interests have kept regulation from working. Such political and

economic power would keep competition from working. Heavy dependence on legalism keeps the transportation system from being effective.

"Potential Impacts of Rail Abandonment on Agricultural Users." Jerome J. Hammond and John O. Gerald (NEAD, ERS, USDA)
This paper briefly summarizes results of a study of rural Midwest rail users located on lines subject to loss of service. Established fertilizer dealers are likely to suffer direct financial loss or a reduction of their growth potential. Grain dealers will not suffer significantly because they use alternative transportation modes.

"The Impact of Unit Trains on Corn Price Relationships at Country Elevators." Linwood A. Hoffman (ERS, USDA, University of Illinois), Steve C. Bermingham, and Lowell D. Hill (University of Illinois)
The effect of unit trains on market destination changes, corn prices paid to farmers, price variability, and daily pricing activities were analyzed at selected country elevators. Two case studies were conducted with country elevators from an Illinois cash grain area. Each case study included one elevator shipping by unit trains and three or four nearby elevators without unit train shipping facilities. Although market destinations changed as a result of unit train shipping, prices paid to farmers did not increase significantly, nor was price variability lessened significantly. Pricing activities seemed to become less related for one case but more closely related for the second case.

"Impacts of Higher Gasoline Prices on Rural Households." Erhardt O. Rupprecht, Jr. (NEAD, ERS, USDA)
Attempts to curtail gasoline consumption through higher prices may result in greater real income reduction for rural than for urban households. Preliminary data indicate they may have considerable difficulty reducing travel distances or switching to alternative modes to offset these losses. Additional data is imperative to effectively analyze equitable energy policy.

Group XXX: Research Methodology (Donald Scott, North Dakota State University, Chairman)

"Adapting the National Input-Output Tableau into a Constrained Optimization Framework for Analyzing Energy Utilization." J. B. Penn, G. D. Irwin (ERS, USDA, North Carolina State University), and Bruce McCarl (Purdue University)
Many current analysis of food and fiber system problems require treatment of its relation to the rest of the economy. Constrained input-output models are one approach for exploring this interaction. Considerations from recent experiences with adapting the nation input-output tableau into a linear programming framework for analyzing energy shortages are discussed.

"A Shortcut Method for Computing Final Demand Multipliers: Some Empirical Results." Paul E. Nelson, Jr. (ERS, USDA) and John Perrin (DPC, Texas)
The relationship between final demand multipliers and the proportion of direct leakage from the economy was tested for stability through time and across sectors of heterogeneous composition. Preliminary results indicate this relationship provides acceptably accurate, easily derived estimates of sector final demand multipliers (the total direct, indirect, and induced effect).

"Adaptations of Reactive Programming in Spatial and Temporal Simulation Analysis." A. Desmond O'Rourke (Washington State University)
This paper explores the conceptual and empirical strengths and limitations of reactive programming, describes its application to selected spatial and temporal problems. Sensitivity analysis confirms the algorithm's versatility and stability in the aggregate.

"Recursive Models and Stabilization Policies: Some Problems and Techniques in Evaluation." S. Chin, D. Hedley, G. MacAulay, and B. Paddock (Economics Branch, Agriculture Canada)
The study of stabilization programs, such as a deficiency payments scheme, is made difficult when expectations of a payment are involved. An approach to modeling a minimum guaranteed price which is announced forward in time is outlined. Some useful measures for evaluating programs follow from the analysis.

"A Theory of Portfolio Adjustments under Uncertainty: A Mean-Variance Approach." Lindon J. Robison (ERS, USDA) and Peter J. Barry (Texas A&M University)
This paper provides a general method for evaluating portfolio adjustments under uncertainty. Adjustments are partitioned into income and substitution effects with theorems describing portfolio equilibrium under alternative degrees of risk aversion. An empirical application uses quadratic programming to evaluate a commercial bank's portfolio adjustments to changes in selected parameters.

Group XXXI: Alternative Strategies for Capital Use (Michael D. Boehlje, Iowa State University, Chairman)

"Effects of Multibank Holding Company Acquisitions of Rural Community Banks." Warren F. Lee and Alan K. Reichert (Ohio State University)
Compared to independent banks, affiliates of multibank holding companies in rural communities compete more aggressively for deposits and loans. They show a greater preference for consumer loans and a decided lack of interest in real estate and farm loans. However, affiliate banks generally are neither more profitable nor more efficient.

"Financial Variables Affecting Capital Structure of

Farm Supply and Diversified Cooperatives." **Donald R. Davidson (Farmer Cooperative Service, USDA)**
The study determined the interrelationships of financial elements changing the capital structure of subject cooperatives. Cooperative growth strategy involved expanding debt and equity at nearly parallel rates. Funds from term debt were applied mainly to financing fixed asset expansion. This freed funds from equity sources for patronage refunds, reducing debt, and strengthening liquidity.

"Alternative Financing Strategies for Farm Supply Cooperatives." Wilmer A. Dahl (Purdue University) and W. D. Dobson (University of Wisconsin-Madison)
Agricultural cooperatives are experiencing pressures to increase cash patronage refunds, reduce capital deductions from members, and reduce capital costs. Farm supply cooperatives could increase cash patronage refunds by over 90% and reduce capital costs by 6%–9% by adopting moderately different capital acquisition and management practices.

"Farm Machinery Leasing: Evaluation and Implications for Measurement of Farm Financial Structure." David A. Lins (ERS, USDA, University of Illinois)
Farm machinery leasing is analyzed with respect to costs and returns, cash flows, and risk. Under certain conditions, a lease may be mutually advantageous to the lessor and lessee. Failure to measure the extent of farm machinery leasing has led to distortions in measures of farm financial structure.

Group XXXII: Land, Water, and Energy (Robert Vertrees, South Dakota State University, Chairman)

"Market and Nonmarket Land Use Decisions: In Search of Concepts and Criteria." Roy Carriker and Burl F. Long (Virginia Polytechnic Institute and State University)
Land use problems are resource allocation problems. This paper examines market and nonmarket land use decision processes for their efficiency implications. Private markets fail to generate efficient land use decisions because of unique characteristics of land. These and certain aspects of the political process mitigate against inherently efficient political decisions.

"Hierarchy of Decision Levels: An Analytical Approach to the Study of Water Institutions in Hawaii." Hiroshi Yamauchi (University of Wisconsin-Madison)
The Wantrupian "hierarchy of decision levels" results from over a decade of analytical research into the allocational functions of land and water institutions throughout much of the United States. This construct proved to be very useful in gaining better insights into how operating levels decisions, private and public, are related to policy level goals through intervening institutional systems.

"Research Needs for Evaluating Land Treatment of Municipal Wastewater." Edwin Young and Lee A. Christensen (NRED, ERS, USDA)
Land treatment of municipal wastewater is receiving increased attention as a wastewater management alternative. Additional research is needed to answer economic and institutional questions surrounding its use. Research issues were categorized into system design consideration and the impacts of land treatment systems.

"Land Reclamation and Strip-Mined Coal Production in Appalachia." William W. Lin, Robert L. Spore, and Edmund A. Nephew (Oak Ridge National Laboratory)
This study quantifies the short-run impacts of reclamation on strip-mining cost, coal price, production, and employment in Appalachia. Full reclamation would have reduced strip-mined coal production by 10 million tons, raised coal price by $0.40 per ton, and cost 1,467 employment opportunities in the Appalachian mining industry in 1972.

"Regional Demand for Electricity and Implications for Policy." G. S. Gill and R. D. Ellison (Oak Ridge National Laboratory)
This study estimates sectoral electricity demand for the Tennessee Valley, employing retail distributor level pooled data. Its design is structured around availability of natural gas. Demand parameters are sufficiently different from those estimated from state data to warrant similar studies for meeting regional power planning and policy evaluation needs.

Group XXXIII: Rural Policy and Recreational Development (Milton Steinmueller, Michigan State University, Chairman)

"Regionalism and Virginia's Planning Districts: A Critical Review." Dennis K. Smith, Sandra S. Batie, and Leonard A. Shabman (Virginia Polytechnic Institute and State University)
Multicounty planning districts in Virginia have a mission of promoting regional economic development. However, existing regional boundaries drawn to meet multipurpose planning goals create impediments to conducting economic development research. Delineation of regional boundaries to meet multiple goals are not adequate for pursuit of individual program objectives.

"Site Quality and the Demand for Recreation: Some Preliminary Empirical Results." Kenneth E. McConnell (University of Rhode Island)
Traditional economic methods for estimating the demand for and net benefits of outdoor recreation were developed primarily for unique sites in remote environs. These methods are not always applicable to unique sites in crowded areas. This paper deals with the problems of estimating the demand for and net benefits of nonunique outdoor recreation

sites in crowded areas. The paper demonstrates methodology and gives an application to Rhode Island beaches.

"Performance of Optimal MSE Estimators Relative to Alternative Predictors of Recreational Use for National Parks." Richard Green and Warren Johnston (University of California-Davis)
The common use of multiplicative models of recreational use (demand) results in difficulties in projecting future values. Alternative estimators are discussed and theoretically optimal mean squared error estimators are compared with ordinary least squares and maximum-likelihood estimators. Empirical results are based on use data for U.S. National Parks from Boyet and Tolley.

"From Farm to Playground—Changing Land Uses and Community Impacts Due to Recreational Subdivision Development." Bart Eleveld and Roger P. Sindt (Texas Real Estate Research Center, Texas A&M University)
Recreational and scenic amenities attract rural subdivision developers in many areas. The effects on the rural community are both economic and sociological in nature. Planning and research in both disciplines can help prevent potential problems and make subdivisions an asset to the original rural population.

"The Economic Impacts of Off-Road Vehicles on Rural Economies: The Upper Great Lakes Case." Marc D. Robertson and Richard C. Bishop (University of Wisconsin-Madison)
Manufacture and use of off-road vehicles, significant only during the last fifteen years, contributed between 0.5% and 1.0% to 1973 household income in the Upper Great Lakes Region. However, increased provision of facilities may not attract more users. Noise, property damage, and trespass externalities are significant though difficult to quantify.

"Rural Development Potentials: A Multivariate Approach." Lynn Reinschmiedt and Lonnie L. Jones (Texas A&M University)
Limited funds available for developing rural industrial or recreation activities demand efficient use. Principal component analysis is demonstrated in selecting significant variables to be used in discriminant analysis. Resulting discriminant coefficients indicate the relative degree of potential each variable contributes toward classifying counties as industrial or recreation oriented.

Award-Winning Theses

Everett, Hal William, II. "Economic and Environmental Impacts of Forest Resource Development." M.S. thesis, Purdue University, 1974.

The development of natural resources can aid in the growth of regional economies. To help federal, state, regional, and local planners make decisions in resource development, impacts of the various policy alternatives must be measured. In this study, the direct economic and environmental impacts of a forest resource development project were measured and their relationship illustrated, and the indirect economic impact was measured at various levels of resource development.

A linear programming model of the forest resource was developed to examine the direct economic and environmental effects of the development of the resource over a fifty-year planning horizon. The sensitivity of the model was examined for changes in three harvesting programs and the level of soil loss. It was found that the allowable harvest program generates higher net revenue than the demand harvest program when soil losses are unrestrained or only slightly restrained. The opposite was true as soil losses became more restrictive. The method of harvest was also affected by the rate of harvest. At low harvesting rates, select-cutting alone was a more profitable alternative to clear-cutting; but as rates increased, either a select-cutting and clear-cutting combination or solely clear-cutting became the more profitable method of harvest. Changes in the rate of discount from 6% to 12% reduced net revenue figures. Lastly, as soil losses were reduced, so was net revenue.

An input-output model of the forested region's economy was utilized to examine the indirect economic impact of the development of the forest resource. It was found that if the timber harvested within the region could also be further processed into secondary or even final products in the region, a large increase in income, employment, and economic development could result.

Forster, David Lynn. "The Effects of Selected Water Pollution Control Rules of the Simulated Behavior of Beef Feedlots, 1974-85." Ph.D. thesis, Michigan State University, 1974.

The failure of a free market to maximize the welfare of society occurs when technical externalities, indivisibilities, or collective consumption is present. Most instances of market failure in the agricultural sector are due to technical externalities. During the past two decades, citizens, regulatory agencies, and legislative bodies have recognized the need for nonmarket force intervention into several areas of agriculture. The externalities associated with pesticides, insecticides, fertilizers, soil erosions, feed additives, and feedlot pollutants have been addressed often during the past two decades.

The focus of this study concerns beef feedlot pollutants which have been deemed one of the more important contributors of agricultural pollution. The analysis is an economic evaluation of selected water pollution control rules and suggested methods and practices for lessening water pollution directed at beef feedlots. These rules and methods and practices have been suggested in order to achieve the environmental policy of no discharge of pollutants into navigable waters.

The purpose of this study was to investigate some of the costs involved in applying a selected set of rules and/or suggested methods and practices. Costs investigated include the costs of the rules in terms of reducing feedlot production and costs incurred by feedlot owners in complying with the rules.

A simulation model was developed to allow the observation of the behavior of feedlots until 1985 under a selected set of rules and/or methods and practices. The feedlots represented by the simulation model were intended to be those in Michigan and surrounding states.

The simulation model attempted to investigate the paths of adjustment of feedlots before and after being subjected to selected rules and/or acceptable methods and practices for water pollution control. The model simulated the production of several individual farm-feedlots through the 1960–85 period. Each simulated firm was given certain initial financial and production characteristics. It was then allowed to develop expectations concerning exogenous prices and expectations concerning its production function. A linear programming solution allowed the firm to produce with the types and amounts of inputs which it expected to be the most profitable. The model simulated the firm's annual operation with actual prices received (*ex post* prices) being different than the expected prices (*ex ante* prices). Similarly, the firm's *ex post* production function was different than the *ex ante* production function used in arriving at the input level the firm employed. Decisions were based on *ex ante* functions while success was determined by *ex post* functions.

Upon the imposition of a rule and/or method and practice to control water pollution, the cost structure of the firm changed. The firm made a decision concerning resources to employ based on the expectations of how the pollution abatement control would affect the profitability of the feedlot. This decision determined the inputs to be used, and pollution abatement resources could have changed the

firm's output as well as the resources employed relative to those produced and employed if no controls had been established.

The selected rules investigated included requirements that all firms: (*a*) have the capacity to control runoff from a ten-year, twenty-four-hour storm by 1977 and from a twenty-five-year, twenty-four-hour storm by 1983; (*b*) have the capacity to control runoff from a twenty-five-year, twenty-four-hour storm by 1977; (*c*) have the capacity to control runoff from a six-month rainfall by 1977; (*d*) adopt the method and practice of storing animal wastes during the winter months plus the capacity to control the runoff from a six-month rainfall, and (*e*) a do-nothing rule.

The four action rules each reduced production and imposed costs on producers over the 1974–85 period compared to the do-nothing rule. The rule that firms have the capacity to control runoff from a ten-year, twenty-four-hour storm by 1977 and a twenty-five-year, twenty-four-hour storm by 1983 resulted in a mean of 7.0 head production decline per firm over the entire 1974–85 period relative to the do-nothing rule. This relative decline was 0.167% of the total. The mean present value of equity losses over 1974–85 as a result of this rule was $3,724 per firm. The second rule, firms have the capacity to control a twenty-five-year, twenty-four-hour storm by 1977 caused a relative decline in production over the 1974–85 period by 7.2 head per firm (0.17% of production) and cost each feedlot owner a mean present value of $3,911. The third rule, a requirement that feedlots have the capacity to control a six-month rainfall, resulted in a mean present value loss of $4,800 per firm and a relative decline in production of 37.7 head per firm (0.90% of production) over the period. The last rule, controlling runoff from a six-month rainfall and adopting the practice of no winter spreading, resulted in a mean present value equity loss of $5,990 per firm with a relative decline in production of 38.3 head per firm (0.91% of production) over the entire period.

Other findings are as follows. Economies of size exist with any of the four rules analyzed in this study. Any of the selected rules were regressive in nature. Reducing the mean net worth of the simulated firms in 1973 by one-half resulted in the cost per dollar of 1973 equity nearly doubling under all four rules. The simulation model was sensitive to several critical parameters. Those parameters strongly affecting model results included the mean net worth of the firm, the determinant of the amount of debt employed by the feedlot, the determinant of the user cost of durable assets, and the initial age of the feedlots. The effects of the four selected rules were nearly the same regardless of feedlot age. The capital outlay required by any of the four rules had a minor impact on the profitability of the feedlot enterprise for all ages of feedlots. The rules had little effect on the asset structure of the firms. While increased asset fixity resulted from the rules, the increase was slight.

Janssen, Larry L. "Comparative Profit Rates of U.S. Manufacturing Firms by City Size." M.S. thesis, Oklahoma State University, 1974.

The major objective of this study is to determine if profit rates in selected U.S. manufacturing industries varied systematically by city size. Estimation of manufacturing company profit rates by city size supplies information to assess the performance of manufacturing industries in responding to comparative profit incentives offered by location in different city sizes. This information combined with an analysis of manufacturing employment trends by city size provides a basis to appraise proposed public policies to further decentralize manufacturing industries from metropolitan to micropolitan (nonmetropolitan) locations.

Multiple linear regression models are developed wherein company profit rates are assumed to be a function of independent variables not associated with city size, city size binary variables and, the interaction of wage rate and plant output variables with city size. Covariance analysis is used to test whether the addition of city size related variables results in a significant explanation of profit rate variation.

The models are applied to 1970 data obtained from published investor sources for a sample of 760 U.S. firms in eleven manufacturing industries: food, textiles, apparel, furniture, paper, printing, chemicals, fabricated metals, nonelectrical machinery, electrical machinery, and transportation equipment.

Results indicated that profit rates are not influenced directly by city size except in one industry. The interaction of plant output or wage rates with city size significantly explained profit rate variation in only four industries.

Findings of this study suggest that industry performance is satisfactory in responding to comparative profit incentives by location. Public policies to improve industrial performance in responding to location incentives would appear to have low priority.

Lifferth, Dennis Ray. "An Economic Analysis of Alternative Rail-Based Grain Distribution Systems." Ph.D. thesis, Iowa State University, 1974.

Technological and economic changes are disrupting the grain distribution system. To provide an efficient grain distribution system, major adjustments are required. Many of the problems of coordinating such adjustments fall beyond the scope of present regulatory policies; they are also beyond the scope of the pricing system because they re-

quire economic agents to know today what actions other agents will take in the future.

The objective of this study is to evaluate alternative rail-based grain distribution systems by analysis of actual production, storage, and transportation elements within a given region. A transshipment plant location model is used to determine the number, size, and location of new subterminals, expansions in storage capacity of existing country elevators, the rail network, and the monthly flows of grain from origins to elevators to destinations to maximize joint net revenue of grain producers within a 6½-county region around Fort Dodge, Iowa. The model is solved using a combinatorial algorithm which compares various feasible solutions, taking into account grain-handling and transportation facilities existing at the beginning of the planning horizon.

The study suggests that a transportation system having fewer rail lines in the Fort Dodge area would increase the joint net revenue of grain producers. Country elevators incapable of loading multiple car trains were used as storage facilities and transshipped much of their grain to market through subterminals. Grain producers shipped to country elevators and subterminals during harvest months and shipped to subterminals during other months. Total net revenue varied by 1%–2% (0.8¢ to 1.6¢ per bushel) over a wide range of abandonment plans.

The study provides an information base for rail abandonment regulation by quantitatively estimating the impact of rail abandonment through systemic analysis, taking into account both inter- and intramodal effects. Various side effects or externalities such as additional energy requirements, road use costs, pollution emission, rail maintenance and upgrading costs, and abandonment of existing elevators are considered in the method of analysis.

Miedema, Allen Keith. "Factor Demands and Particulate Emission Control Regulations: The Case of Steam-Electric Power Plants." Ph.D. thesis, North Carolina State University, 1974.

This study analyzes the influence of particulate matter emission control regulations as applied to coal-fired plants in the steam-electric power generating industry on the demand for input by firms within the industry. Coal-fired plants were particularly appropriate for this analysis since they have historically been subject to particulate matter emission controls. This afforded empirical observations on many plants which manifest input combinations influenced by more than two decades of regulative controls.

A neoclassical production model with an emission constraint was utilized. Output was presumed exogenous and firms were viewed as minimizing cost-subject output and emission constraints. The production function was assumed separable in three inputs among which the coal (fuel) input was regarded joint to both power production and particulate matter collection processes.

The cross-section analysis of 1969 plant operations used Federal Power Commission data from which an eighty-plant sample was selected by applying criteria suggested by the theoretical model. Demand equations were estimated for air pollution control inputs, fuel inputs, capital, and labor in power generation. Explanatory variables included particulate emissions per unit of fuel heat input, the fuel waste (ash) content, plant output (size times capacity utilization), relative factor prices, and dummy variables to account for intertemporal effects.

The empirical results suggest that air pollution control regulations generally pervade all input decisions of the plant. The cost of pollution control regulations, therefore, includes this effect on all inputs used by the plant. The ash content of coal appears to have little effect on the demand for inputs other than those directly related to pollution control. The estimated effects of plant scale on the demand for pollution control inputs suggests that policy makers should reconsider regulations which reduce allowable emissions per unit of fuel input as plant size increases.

Schaefer, Henry Hollis. "The Determination of Basis Patterns and the Results of Various Hedging Strategies for Live Cattle and Live Hogs." M.S. thesis, Iowa State University, 1974.

Futures markets offer producers an opportunity to forward price their products but they also create decision problems: producers must select hedging strategies. The objectives of this study were (*a*) to develop a framework for defining and comparing hedging strategies; (*b*) to formulate alternative hedging strategies that may be used by Iowa livestock feeders; (*c*) to test selected hypotheses concerning the level and variability of the near-month basis (the near-month futures price minus the cash price); and (*d*) to use simulation analysis to compare the mean and variability of net returns from alternative hedging strategies.

Five alternative hedging strategies were developed. These included two "naive" strategies, never hedge and always hedge, and three "selective" strategies. A different rule for deciding whether to place a hedge was used in each selective strategy. In one the decision was made by comparing the forecasted cash price with the estimated net price with a hedge (target price); in another, a Bayesian decision procedure was used; and in the other, a decision rule based on changes in a ten-day, moving-average price was used.

Cash price forecasts for the first selective strategy were obtained from a model developed in another study. An estimate of the basis on the marketing date was needed to calculate each target

price. A procedure for estimating the basis was developed and selected hypotheses concerning the level and variability of the basis were tested. Simulation models were used to generate results for each hedging strategy for each of three cattle and three hog feeding systems.

The results of the basis analysis indicated that there are seasonal patterns to the basis and that the basis converges to a nonzero equilibrium value in each delivery period. The simulation results indicated that strategies with higher mean net prices also have higher variances of net price.

AAEA Business

Committee Reports

Report of the President

It has been a privilege, as well as a challenge, to serve as president this past year. During the year, we have faced some of the most crucial issues confronting the American Agricultural Economics Association in at least ten years.

One of the crucial issues is related to publication policies, i.e., how much and what kind of material the AAEA should publish and the form in which it should be published. A committee chaired by C. B. Baker made recommendations for achieving the objectives outlined by the Stephen Smith committee that reported in 1974.

Publication policies are closely related to and are a part of the most critical issue, finances, since over 75% of the AAEA's budget is used to publish the *Journal*. In spite of economy measures followed by the Secretary-Treasurer, the editors, and the Board, the operating deficit that was nearly $23,000 in 1973 grew larger in 1974 and will be larger yet in 1975. Services to members have not been increased substantially. The deficits have resulted from rapid inflationary increases in costs while dues have remained static at a low level relative to other professional societies.

One of my first acts as president was to appoint an ad hoc finance committee. This committee, under the chairmanship of B. F. Stanton, accepted major responsibility for studying the AAEA's financial problems and making recommendations for action. It helped firm up the plans for initiating page charges as discussed at last year's annual business meeting. After careful and detailed study, the committee suggested the increase in dues to $25 for regular members that is recommended by the Board for action at this meeting. The Board is recommending an amendment to the Bylaws to establish a permanent Finance Committee; the committee would perform functions designed to help keep the AAEA on track financially.

Some other major actions taken by the Board during the past year are as follows (reports from all of the committees will be found in this issue). On recommendation from the Bibliographical-Retrospective Search Committee, as well as from a Special Review Committee, the Board voted to cease publication of the *American Bibliography of Agricultural Economics*. Agricultural economists need to have rapid and efficient access to agricultural economics literature. With this in mind, efforts are being made to place a computerized search system on line early in 1976. The system will be useful only if members work at providing inputs and will be worth the cost only if they use the outputs.

Good progress has been made in developing and evaluating a computer-based employment registry for agricultural economists, financed by a grant from the Manpower Administration. In cooperation with the Employment Services Committee, the Board is exploring future means of financing this service that can be increasingly valuable to agricultural economists and employers.

All chapters of volume I of the Postwar Literature Review, *Traditional Agricultural Economics*, were completed by May of this year. With the help of a special committee, the Board is exploring means of publishing and marketing this volume as well as volume II, *Quantitative Methods*, expected to be in final form by the end of 1975, and volume III, *New Fields in Agricultural Economics*, expected by the fall of 1976.

The next *Handbook-Directory* will be published in 1976.

In 1973, the Board accepted the recommendation of a special committee, chaired by James Plaxico, that student contests at the annual meetings be discontinued after 1974 and that other activities be used to involve undergraduate students in the annual meetings. As recommended by the Resident Instruction Committee, at this year's annual meeting there is an invited papers session organized by the committee, another organized by the officers of the student section, and eight undergraduate students are presenting contributed papers. Additional ways of involving students are being sought by the committee and the Board.

The Board accepted the recommendation of the Economic Statistics Committee that the AAEA help organize and sponsor task forces to study selected economic data series of the Economic Research Service.

During the year, the International Committee completed an excellent study of international training and made a number of recommendations for follow-up activities on international education. The Board accepted essentially all of these recommendations as well as one that $5,000 be provided to assist younger agricultural economists to attend the conference of the International Association of Agricultural Economists in Kenya in 1976.

Since its establishment in 1973, the AAEA has repeatedly been urged to become a member of the Council on Agricultural Science and Technology (CAST), and over seventy-five agricultural economists have served on CAST task forces. This motivated us to appoint a committee to make recommendations on whether the AAEA should become a member. This committee conducted a very

careful review. While it believes that CAST serves a useful purpose in providing scientific input to policy decisions, the committee recommended that we not join CAST at this time. We will continue to carry on our liaison with the Council.

Because of my conviction that many members can make significant contributions to the AAEA as well as benefit from participation, I tried hard to obtain as broad participation as possible among members. This concept was before us in appointing people to committees, in soliciting suggestions, and in inviting people to help plan and appear on the annual meeting program. I especially strived to involve agricultural economists who had not previously been involved in AAEA activities. I exerted special efforts to get more involvement in AAEA activities by agricultural economists working in industry. Among other things, I am pleased to report that at least seventeen industry economists are appearing on the annual meeting program this year, a number of them giving major papers.

I appreciate the response in terms of the fine work done by the chairmen and members of the more than twenty AAEA committees, and by those who helped plan and those who appeared on the program at both the winter meeting and the annual meeting. I want to acknowledge the contribution of the Board; it has been an active, hard working one which has faced many difficult problems. John Redman continues to do a dedicated job as Secretary-Treasurer of the AAEA. Max Langham and Leo Polopolus, and more recently Bill Tomek and his associates, have served the AAEA well in the important job of editors. Francis McCormick and all of the rest of the Agricultural Economics Department at Ohio State University did an outstanding job with the local arrangements for the annual meeting and were fun to work with.

A society such as ours can do much for the profession it serves. Even with all of its problems and imperfections, the AAEA does a great deal for the agricultural economics profession, and with adequate support, can do even more in the future. All of us ought to accept responsibility to serve as ambassadors to convince agricultural economists who are not now members that they have much to gain by joining and participating.

Respectfully submitted,
James Nielson
President

Resolution

The Ohio State University, its president, and the faculty, staff, and students of the Department of Agricultural Economics and Rural Sociology have shown warm and cordial hospitality to the members of the AAEA, their families, and guests and to the AAEA officials on the occasion of the annual meeting held at Columbus, Ohio, August 10–13, 1975.

Therefore, be it resolved that the AAEA express its sincere gratitude to President Harold Enarson, Dean Roy M. Kottman, and to David H. Boyne, Chairman of Department of Agricultural Economics and Rural Sociology and his faculty, staff, students, and their families for their hospitality. Under the superb leadership of Francis McCormick as chairman, the Local Arrangements Committee has worked hard and long and served us efficiently and graciously.

Be it further resolved that this resolution be made officially a part of the proceedings of the AAEA and published in its *Journal* and that a copy of this be sent to President Enarson, Dean Kottman, Professors Boyne and McCormick, and to others at Ohio State University as appropriate.

Report of the Secretary-Treasurer

The total number of members and subscribers increased in 1974 by 297 over the low experienced in 1973 (table 1). Most of the increase came about in the regular membership category. We had a substantial reduction in our foreign junior membership category. Also, the number of institutional members has declined steadily. Considerable effort is being made to increase our membership in all categories.

Table 1. Number of Members and Subscribers, 1974, with Comparisons

Category		1969	1970	1971	1972	1973	1974
Institutional members		45	39	34	25	20	22
Regular members	U.S.	2,854	2,667	2,856	2,802	2,504	2,756
	Foreign	566	534	486	601	487	480
Junior members	U.S.	518	494	635	398	316	338
	Foreign	61	84	53	38	161	68
Corresponding	U.S.	2	4	2	—	—	1
	Foreign	179	95	100	82	184	198
Libraries and businesses	U.S.	645	596	619	647	635	667
	Foreign	1,090	1,031	1,111	1,196	1,168	1,242
Exchange		3	3	2	2	3	3
Total		5,963	5,547	5,898	5,791	5,478	5,775

In examining an operating statement, one must be careful not to let extraordinary items reflect as normal activity. The 1974 statement shows a deficit of $39,895.66 (table 2). As you know, the activities of the Employment Committee are financed by a grant from the U.S. Department of Labor. When the $32,000 received in 1974 from the USDL is subtracted from the income received and the $49,666.24 spent by the Employment Committee is subtracted from expenses, the AAEA experienced a deficit of $22,229.42. To get a true picture of where the AAEA stands with respect to this particular grant as of December 31, 1974, the $12,399.66 expended in 1973 and $49,666.24 expended in 1974, or a total of $62,065.90, should be subtracted from $37,500 received in 1973 and $32,000 received in 1974, or a total of $69,500, which leaves a total of $7,434.10 in unspent funds as of December 31, 1974.

In the annual meeting income, the AAEA received $1,627.78 from the University of Alberta as a share of surplus, $2,000 from Texas A&M as repayment of an advance made, and $565.56 from the American Economic Association as the AAEA's share of surplus. On the expense side of annual meetings is the $2,000 advance made to Texas A&M.

In the miscellaneous income category, the AAEA received $15,000 from the Rockefeller Foundation as a grant to be used by the Agricultural Development Council to finance activities of the AAEA International Committee; $216.40 in postage col-

Table 2. 1974 Operating Statement with Comparisons and 1975 Budget

	1973 Actual	1974 Budget	1974 Actual	1975 Budget
Income				
Dues and subscriptions				
Regular members	$ 56,513.62	$ 56,000	$ 53,723.13	$ 57,000
Junior members	1,983.84	3,400	2,607.92	2,200
Subscriptions	35,141.97	37,000	38,430.19	36,000
Corresponding	840.00	200	930.00	500
Institutional	2,000.00	2,500	2,200.00	2,200
ABAE	5,230.87	5,000	5,261.76	4,000
Dividends and interest	7,799.37	7,400	8,593.25	7,800
Journal sales	4,444.89	5,600	5,273.75	4,500
Reprints	3,259.31	3,000	4,452.50	3,300
Page charges	—	—	—	32,000
Address labels	835.12	500	935.40	1,000
Advertisments	1,065.00	600	819.64	800
Student activities	—	250	—	—
Annual meetings	344.67	700	4,193.34	200
Employment committee	37,500.00	—	32,000.00	—
Miscellaneous	5,026.90	3,000[a]	16,335.53	3,000[a]
Total	$161,985.56	$125,150	$175,756.41	$154,500
Expenses				
Journal printing	$ 70,483.40	$ 52,500	$ 81,752.64	$ 75,000
Editorial support	15,600.00	23,400	23,400.00	17,700
Printing reprints	1,843.76	2,000	3,152.71	2,500
Address labels	316.23	200	—	200
Purchase journals	1,028.80	2,000	569.64	1,000
Postage and phone	1,679.09	2,600	2,962.58	3,000
Office supplies and printing	2,932.18	2,500	2,385.91	3,000
Annual meeting	1,485.46	2,500	4,460.74	2,000
Awards	600.00	800	1,500.00	1,500
Committees	272.68	1,200	357.25	1,200
Bonds	298.00	160	149.00	160
Student activities	842.90	1,200	1,129.89	1,200
Sec.-Treas. assistance	12,851.48	15,900	13,874.50	14,300
Sec.-Treas. honorarium	4,000.00	4,000	4,000.00	4,000
ABAE	7,729.33	7,000	10,655.14	18,000
IAEA grant	5,000.00	—	—	—
Audit	—	1,000	200.00	1,000
Employment committee	12,399.66	—	49,666.24	—
Miscellaneous	9.76	4,000[a]	15,435.83	7,200[a]
Total	$139,372.73	$122,960	$215,652.07	$152,960
Balance	$ 22,612.83	$ 2,190	$−39,895.66	$ 1,540

[a] Includes $2,000 advance and/or repayment.

lected in mailing returned issues of the *Journal*; $462.21 as royalty; $422.50 as miscellaneous back dues; $139.00 as overpayment of dues; $85.00 gift; and $10.42 as exchange premium. The miscellaneous expense category is made up with $15,000 as ADC grant (Rockefeller); $29.33 in exchange charges; $24.00 in copyright fees; $1.00 as Iowa registration fee; and $381.50 as refunds (overpayment of dues).

At all times, every effort has been made to hold expenses down and enhance our income wherever possible. However, a deficit was experienced! As compared to the 1974 budget, the biggest deviation was associated with the *Journal*. A part of this difference, $3,349.37, was due to moving the *Journal*.

In accordance with the policy established in 1973, coeditors Polopolus and Langham provided an income-expense statement for the editorial support

Table 3. Operating Statement of Editorial Support, Polopolus and Langham, 1974

Income	
AAEA appropriation to *Journal*	$15,600.00
Interest on savings account	550.64
Total	$16,150.64
Expenses	
Postage	$ 1,248.00
Copywork	200.46
Telephone	171.43
Supplies	117.07
Salaries (including fringe benefits):	
Editorial assistant	10,474.70
Secretary	3,823.69
Other	118.95
Total	$16,154.30
Balance	$ −3.66

Table 4. Operating Statement of Editorial Support, Tomek, July 1–December 31, 1974

Income		
AAEA appropriation to *Journal*		$ 7,800.00
Expenses		
Nonrecurring expenses		
Purchase of dictionary, equipment, supplies, etc.	$501.76	
Travel to visit printer	117.36	
Subtotal		$ 619.12
Recurring expenses		
Salary, secretary (6 months)	$3,921.00	
Salary, assistant editor (5 months)	3,269.00	
Supplies	213.60	
Telephone	145.33	
Postage	580.37	
Photocopying	132.36	
Subtotal		$ 8,261.66
Total		$ 8,880.78
Balance		$ −1,080.78

Table 5. Balance Sheet, December 31, 1974, with Comparisons

	1972	1973	1974
Assets			
Cash—bank	$ 63,540.82	$106,217.77	$ 61,629.15
Cash—agency act UK	1,559.27	(135.99)	291.25
Cash—broker	14,788.27	2,123.08	1,896.63
Prepaid expense	—	—	8,850.00
Investments			
Stocks (at cost)	$102,551.99	$102,551.99	$102,551.99
(Approximate market value)	214,096.75	182,866.125	136,432.625
Total assets (at cost)	$182,440.35	$210,756.85	$175,219.02
Liabilities			
Prepaid membership dues	$ 22,192.00	$ 27,895.67	$ 32,253.50
Prepaid *ABAE* subscriptions	—	—	—
Accounts payable	30,116.10	30,116.10	30,116.10
Net worth	$130,132.25	$152,745.08	$112,849.42
Total liabilities	$182,440.35	$210,756.85	$175,219.02

for 1974 (table 3). As you know, the location of the editorship was moved from Gainesville to Ithaca and $7,800 in editorial support was provided to enable the new editor to function properly. Editor Tomek provided an income-expense statement for the six months (table 4).

The balance sheet for AAEA for 1974 showed a decrease of $39,895.66 over 1973 (table 5). If the USDL grant funds were subtracted from both income and expenditures, the net worth would show a decrease of $22,229.42. It was reported for last year (1973) that when the USDL funds were accounted for, the AAEA experienced a deficit of $2,487.51 making our net worth actually $127,644.74. With our $22,229.42 deficit in 1974, our actual net worth is $105,415.32 since we have $7,434.10 in unspent funds which are included in the $112,849.42 net worth figure for 1974. Our stock is carried on the books at cost. The market continues to be unkind to us, giving us a "paper loss" of $46,433.50 for the year.

It is obvious that the income is not sufficient to finance the ongoing activities of the AAEA. Something must be done to enhance income or cut expenses or both.

Respectfully submitted,
John C. Redman
Secretary-Treasurer

Report of the Audit Committee

The Audit Committee employed Arthur C. Wilson, Certified Public Accountant, to examine the financial records of the American Agricultural Economics Association for 1974. The last paragraph of his report is as follows. "In our opinion, the accompanying balance sheet, statement of receipts and disbursements, and statement of change in fund balance present fairly the financial position and results of operation of the AAEA at December 31, 1974, and for the year then ended, in conformity with generally accepted accounting principles consistently applied."

James E. Criswell
Larry D. Jones

Report of the Investment Committee

The portfolio of investments by the AAEA did not change during 1974. The stocks carried on the books at a cost of $102,551.99 had a market value of $136,432.625 at the close of the business year, decreasing by $56,433.50 from the previous year (table 1). Our investments in stocks yielded $8,593.25 in dividends (table 2).

The AAEA had only two stocks—American Cyanamid and Continental Can—which were worth

Table 1. AAEA Summary of Investments, December 31, 1974

	Income	Value: Cost	Value: Market
Stocks			
On hand, Jan. 1, 1974		$102,551.99	$182,866.125
On hand, Dec. 31, 1974		102,551.99	136,432.625
Dividends	$8,593.25		

Table 2. AAEA Stocks, December 31, 1974

				Market Value	
Company[a]	No. of Shares	Original Cost	Dividends 1974	Dec. 31, 1973	Dec. 31, 1974
Amer. Cyanamid (A)	250	$ 9,143.43	$ 362.50	$ 4,843.75	$ 5,187.50
Amer. Tel & Tel (A+)	288	11,421.11	910.08	14,436.00	12,852.00
Amer. T&T $4CV (AA)	300	16,934.00	1,200.00	17,212.50	14,625.00
Borden (A+)	228	2,162.41	285.00	4,788.00	4,617.00
Chase Manhattan (A+)	93	1,115.09	204.60	5,254.50	2,511.00
Clark Equipment (A−)	600	2,200.67	960.00	27,900.00	13,800.00
Con. Edison (A)	232	7,467.14	533.60	6,757.00	5,162.00
Cont. Can (A)	225	4,315.38	371.25	4,612.50	5,850.00
Exxon (A+)	153	10,325.36	765.00	14,401.125	9,887.625
Goodyear (A)	500	16,692.50	512.50	7,625.00	6,437.50
Jewell (A)	100	3,875.94	173.00	3,112.50	1,737.50
Nor. Ill. Gas (A)	7	—	13.32	152.25	122.50
Sears Roebuck (A+)	304	1,845.38	562.40	24,396.00	14,668.00
Std. Oil Ind. (A+)	800	7,356.68	1,320.00	41,500.00	34,800.00
Texaco (A+)	200	7,696.90	420.00	5,875.00	4,175.00
Total		$102,551.99	$8,593.25	$182,866.125	$136,432.625

[a] Standard and poor ratings shown in parentheses.

more at the end of 1974 than at the beginning. However, those stocks took a beating last year. Based on cost, an 8.4% rate of earnings was realized, but when based on market value at the beginning of the year, only 4.7% was realized.

Respectfully submitted,
John C. Redman
Chairman

Report of the Tellers Committee

Ballots received from the Secretary-Treasurer of the AAEA were counted by the Tellers Committee in the manner prescribed by the Bylaws to preserve the secrecy of the ballots. The following candidates received the largest number of votes in their respective categories: Kenneth R. Farrell for President-Elect, Wallace Barr for Director, and Philip M. Raup for Director.

A. Frank Bordeaux, Jr.
Harry H. Hall

Report of the Editor

The past year was an eventful and busy one for the new editorial staff. Your editor has been involved in responding to the recommendations of the *Journal* Evaluation Committee, in implementing the page charge approved by the directors of the AAEA, in making changes in the style of the *Journal*, and in the ongoing process of manuscript review.

The editors and the editorial council have tried to be responsive to the recommendations made to them by the *Journal* Evaluation Committee. As recommended, our policy is to insist that the mathematics in a manuscript be essential and that papers have some application to a policy or methodological question. Also, as recommended, some articles and notes in volume 57 deal with problems, ideas, and issues largely in prose, but I am not sure that this is the direct result of the editor's actions. We must work with the manuscripts submitted, and efforts to encourage diversity in the type of submissions have not been as effective as I would have liked. In this regard, our experience differs little from those of past editors (e.g., see the editor's report for 1972). Nonetheless, some manuscripts of reasonable quality with little or no mathematics are being submitted.

To date, I have been very conservative about inviting review articles. The AAEA is in the process of publishing a literature review series in book form, and the *Journal* obviously should not duplicate this effort. Moreover, as I shall report in a moment, we have a large supply of manuscripts under review, and this raises a question about using scarce *Journal* space for invited papers. In this context, I will probably invite a very few reviews on rather specific topics. Since so much statistical analysis in applied economics involves Sherlock Holmes inference, i.e., hunting for significant results, the first review will likely be about the statistics of such procedures. The intent will be to appeal to a broad audience by providing a non-technical review of the statistics and econometrics literature on sequential estimators.

Since mid-March, we have tried to make authors anonymous in the review process. There have been no objections from reviewers. The biggest problem is that many authors defeat the system indirectly by identifying themselves in the text or through citations. The objective of anonymity is to place new and established authors on an equal footing in the review process, but we need the cooperation of authors if the process is going to work.

A statement was prepared to explain the page charge policy, and in addition the statement required with the submission of manuscripts was changed to more clearly reflect the copyright status of the *Journal*. Neil Harl, the AAEA's legal counsel, generously assisted with the preparation of the statements. The reprint order form sent to authors with galley proofs was redesigned to reflect the page charge. The page charge procedures appear to be working well. The authors in the August issue have been cooperative. One problem has been to get the printer to send the appropriate form about the page charge out with the galley proofs.

Numerous changes have been made in the style of the *Journal*. The intent is to improve readability and appearance while at the same time having a simple, economical design. Carol Burns, the assistant editor, deserves the credit for working on and implementing these design changes. We have also had fine cooperation from the printer, Heffernan Press, Inc. of Worcester, Massachusetts. They have been responsive to our requests, and they provide relatively error free galleys.

Our most important activity is, of course, the processing of manuscripts. In the past year, 332 new submissions were received, up 47 from 1973–74 (table 1). Our office also finished processing 59 manuscripts that started the review process at Florida. This has meant that the editor and associate editors have had to identify more reviewers, write more editorial responses, etc. that the *Journal* secretary, Ruth Mezei, has had an increased burden of correspondence and clerical duties, and that office expenses such as postage have risen. In addition, our office will process 56 proceedings papers for volume 57 (table 2). The *Journal* staff is working at full capacity. Indeed, the assistant editor and the secretary for the *Journal* are receiving supplementary help from departmental secretaries.

With the increase in submissions, the acceptance rate declined from 34% to 27% (table 1). Part of the decline is explained by the lag between submission and publication; the larger number of submissions is not immediately matched by more acceptances. Many of the manuscripts submitted in 1974–75 will

Table 1. New Submissions, Manuscripts Accepted, and Acceptance Rate, 1965–66 to 1974–75

Year	Number of New Submissions[a]	Manuscripts Accepted for Publication	Acceptance Rate, %
1965–66	218	87	40
1966–67	195	96	49
1967–68	212	100	47
1968–69	268	105	39
1969–70	249	95	38
1970–71	250	96	38
1971–72	264	96	36
1972–73	263	90	34
1973–74	285	98	34
1974–75	332	91	27

[a] Excludes proceedings papers and book reviews.

appear in 1976 issues of the *Journal*. In addition, our insistence that manuscripts have some applicability to a problem or make a clear contribution to the literature has probably accounted for part of the decline.

Assuming the acceptance rate returns to about 30% of the manuscripts submitted, then *ceteris paribus* the number of pages in the *Journal* would have to increase or a backlog of manuscripts will build up. At present, there is no backlog of unpublished manuscripts, and I hope that we can maintain our history of prompt publication of accepted manuscripts. The publication of more pages in the *Journal* as well as the added burdens on the editor's office mean larger expenses in publishing the *Journal*. I have provided details on these expenses to the Finance Committee. One method of controlling printing costs would be to maintain the *Journal* at its current size while changing the mix of refereed and invited papers. Specifically, the directors may want to consider devoting more pages to refereed manuscripts and fewer to invited proceedings papers.

With the classification of manuscripts accepted for publication as either articles or notes, the number of papers classified as articles has risen (table 2). The new classification scheme has been relatively easy to administer, and I hope that both readers and authors are satisfied with it.

In closing, I wish to thank a number of persons for their assistance. The transfer of the editor's office to Cornell was greatly facilitated by the gracious cooperation of Max Langham, Leo Polopolus, Marcia Heighton, and their associates at Florida. I also wish to express appreciation to the members of the editorial council, the book review editor, and the associate editors for their willingness to serve in these important capacities. In addition to the 16 members of the editorial council, 361 individuals assisted us by providing one or more reviews. Their names are listed in table 3. Through the cooperation of department chairmen, I compiled a long list of potential new reviewers. Our policy is to use a younger member of the profession as one of the two reviewers when the topic of the manuscript and the interests of such reviewers coincide. Frank, careful reviews make an important contribution to the *Journal* and to the profession. Thus, while a few reviews are carelessly done, I am thankful for the vast majority of reviewers who take their jobs seriously.

William G. Tomek
Editor

Table 2. Number of Articles, Notes, and Proceedings Papers Published, 1972–75

	1972	1973	1974	1975
Articles	30	22	25	48
Notes	66[a]	68[a]	73[a]	43
Proceedings	60	51	58	56
Total	156	141	156	147

[a] Short articles and communications combined.

Table 3. Reviewers, July 1974–June 1975

Dale W. Adams
Masakatsu Akino
Jay C. Andersen
Jock R. Anderson
W. J. Anderson
Francisco J. Andrade
Robert C. Angus
Michael Applegate
Walter Armbruster
Harry W. Ayer
Emerson M. Babb
Henry Badger
C. B. Baker
E. Dean Baldwin
A. Gordon Ball
P. K. Bardhan
Hiram C. Barksdale
Richard L. Barrows
Peter J. Barry
Joseph R. Barse
Sandra Batie
C. Phillip Baumel
Jere R. Behrman
Monroe Berkowitz
E. R. Berndt
Arlo W. Biere
Leo V. Blakley
Michael Boehlje
Jean-Marc Boussard
Robert F. Boxley
George E. Brandow
Maury Bredahl
Harold F. Breimyer
Thomas A. Brewer
George L. Brinkman
S. M. Brock
Ray Brokken
Ralph M. Brooks
Gardner Brown
William G. Brown
J. Bruce Bullock
Oscar R. Burt
Rueben C. Buse
W. V. Bussmann
Walter Butcher
Boyd Buxton
Daryl Carlson
Gerald A. Carlson
Thomas F. Carroll
Kenneth L. Casavant
Emery N. Castle
Frank J. Cesario
S. N. S. Cheung
Dennis Chinn
Shih-fan Chu
Robert I. Coltrane
Dale K. Colyer
Frank S. Conklin
Larry J. Connor
Sam M. Cordes
Richard H. Courtney
K. G. Cowling
Richard J. Crom
Robert W. Crown
Ronald G. Cummings
Dale C. Dahl
Dana G. Dalrymple
Raymond Daniel
Elizabeth David
Lee M. Day
Alain de Janvry
Carleton C. Dennis
Pritam S. Dhillon
Carlos Diaz-Alejandro
John L. Dillon
C. Dirck Ditwiler
Gerald A. Doeksen
Otto C. Doering
John P. Doll
Arthur L. Domike
Robert Dorfman
Peter P. Dorner
Folke Dovring
H. Evan Drummand
Kenneth D. Duft
S. Eckstein
Clark Edwards
Vernon Eidman
Joachim Elterich
Peter Emerson
Donald J. Epp
Edward Erickson
Robert Evenson
Darrell F. Fienup
Loyd K. Fischer
W. L. Fishel
Anthony Fisher
Lehman B. Fletcher
Raymond J. Folwell
D. Lynn Forster
John R. Franzmann
Ben C. French
R. J. Freund
B. Delworth Gardner
Bruce L. Gardner
Peter V. Garrod
P. S. George
Paul H. Gessaman
Micha Gisser
E. Bruce Godfrey
Frank M. Goode
John W. Goodwin
Richard Green
R. Clyde Greer
James M. Griffin
Russell L. Gum
Walter Haessel
Milton C. Hallberg
Albert N. Halter
Jerome W. Hammond
Timothy M. Hammonds
Charles R. Handy
David E. Hansen
Ian W. Hardie
William E. Hardy, Jr.
Neil E. Harl
David Harrington
Gerald A. Harrison
Stephen B. Harsh
Paul R. Hasbargen
Joseph Havlicek
Yujiro Hayami
Peter B. R. Hazell
J. C. Headley
Theodor H. Heidhues
Dale M. Heien
Richard G. Heifner
Robert Herdt
Robert Herendeen
William Herr
Robert O. Herrmann
Judith Heyer
T. A. Hieronymus
R. James Hildreth
Lowell D. Hill
Jimmye S. Hillman
Fred K. Hines
Eithan Hochman
Thomas F. Hogarty
David W. Holland
Peter Hopcraft
John A. Hopkin
David Hopper
Gerald L. Horner
James P. Houck
Darrell Hueth
Wallace E. Huffman
Robert F. Hutton
Loren A. Ihnen
John E. Ikerd
Geoffrey Jackson
J. Dean Jansma
Frank G. Jarrett
Harald R. Jensen
Robert B. Jensen
Paul R. Johnson
S. R. Johnson
Stanley S. Johnson
Richard S. Johnston
Desmond Jolly
Larry Jones
Lonnie L. Jones
Richard E. Just
Don Kanel
Earl W. Kehrberg
M. P. Kelsey
Richard A. King
Yoav Kislev
Rodney C. Kite
Peter Knight
T. A. Kofi
Marvin W. Kottke
Daryl Kraft
K. R. Krause
Peter J. Kuch
Robert G. Kuller
John Kushman
George W. Ladd
Larry N. Langemeier
Lawrence J. Lau
Lester B. Lave
T. C. Lee
Warren F. Lee
Raymond M. Leuthold
Steve Levine
Franklin J. Levinson
Lawrence W. Libby
Dennis R. Lifferth
Samuel H. Logan
Burl Long
Ralph A. Loomis
William Lord
Daniel P. Loucks
Donald W. Lybecker

Table 3. Continued

Francis McCamely	Anthony A. Prato	Marvin J. Sternberg
Bruce McCarl	David W. Price	Robert D. Stevens
James McFarland	Wayne D. Purcell	Thomas F. Stinson
Andrew M. McGregor	Malcolm J. Purvis	Ian M. Sturgess
John P. McInerney	Hans D. Radtke	Abraham Subotnik
Melville L. McMillan	Ronald E. Raikes	P. A. V. B. Swamy
Gene McMurtry	Alan Randall	Kenneth G. Swanberg
J. Patrick Madden	Philip Raup	Earl R. Swanson
Richard B. Mancke	Gordon C. Rausser	Takashi Takayama
Lester V. Manderscheid	Daryll E. Ray	H. Talpaz
J. S. Mann	A. J. Rayner	William C. Thiesenhusen
Harry P. Mapp, Jr.	John C. Redman	Kenneth H. Thomas
Richard T. Marasco	Robert B. Reese, Jr.	L. J. Thomas
Larry J. Martin	Terry Roe	Robert L. Thompson
Lee R. Martin	George B. Rogers	William N. Thompson
R. Thomas Martin	Anthony S. Rojko	C. Peter Timmer
William E. Martin	Gordon Rose	Peter Tryfos
Jimmy L. Matthews	James Roumasset	Stephen J. Turnovsky
Stephen F. Matthews	Sujit K. Roy	Luther G. Tweeten
H. A. Meier	Abdullah A. Saleh	Fred H. Tyner
K. D. Meilke	P. L. Scandizzo	Edward W. Tyrchniewicz
Joseph C. Meisner	Harry Schaffer	Jan H. van der Veen
Richard L. Meyer	A. Allan Schmid	Edward J. Vander Velde
Edgar L. Michalson	John R. Schmidt	W. van Vuuren
Thomas A. Miller	Stephen G. Schmidt	John J. Waelti
C. V. Moore	Lee F. Schrader	Arley D. Waldo
Timothy D. Mount	Dean F. Schreiner	Rodney Walker
Jürgen Müller	Ronald A. Schrimper	T. D. Wallace
Delbert R. Myren	G. Edward Schuh	Richard G. Walsh
A. Gene Nelson	John T. Scott, Jr.	Forrest Walters
Glenn L. Nelson	Stanley K. Seaver	Ronald W. Ward
Paul E. Nelson, Jr.	W. D. Seitz	Peter Warr
John P. Nichols	Gerald L. Setter	Leonard Waverman
Richard B. Norgaard	Benjamin Sexauer	Thomas F. Weaver
Ronald M. North	Leonard Shabman	Robert C. Wells
J. Frank O'Conner	James D. Shaffer	Fred White
Desmond O'Rourke	Ronald E. Shaffer	Norman K. Whittlesey
Charles E. Overton	Jerry A. Sharples	Cleve Willis
A. Parikh	L. H. Shaw	Ian R. Willis
Quirino Paris	C. Richard Shumway	George W. Wilson
William L. Park	Richard L. Simmons	Larry Wipf
Earl J. Partenheimer	J. A. Sinden	Robert H. Wisner
D. W. Parvin, Jr.	Daniel G. Sisler	Jerome M. Wolgin
E. C. Pasour, Jr.	Charles Sisson	A. W. Wood
Anne Peck	Leslie Small	Fred Woods
Neil H. Pelsue	Blair J. Smith	David P. Worley
J. B. Penn	V. Kerry Smith	Gene L. Wunderlich
R. K. Perrin	Ronald Soligo	J. B. Wyckoff
Willis L. Peterson	Robert G. F. Spitze	Chung Jeh Yeh
T. P. Phillips	T. L. Sporleder	Russell C. Youmans
Ronald R. Piggott	James L. Stallings	James Zinser
Stanley R. Pliska	Martin S. Stauber	
A. A. Powell	Anthony P. Stemberger	

Note: Editorial Council members are listed inside the front cover.

Report of the Ad Hoc Finance Committee, 1974–75

President Nielson appointed an ad hoc Finance Committee in August 1975 to review recent financial experience and commitments of the AAEA, to examine major enterprises and activities of AAEA and assist in preparing a budget for 1976, to make recommendations to the Executive Board on ways to balance expenses with income and report to the membership, and to review the process by which the AAEA's investment portfolio is managed and make recommendations.

The committee prepared a statement describing AAEA commitments and expenses over the past two years and projected for 1976 which was distrib-

uted to all members with a letter from the president in April 1975. It recommended that the basic dues structure be increased in 1976 to $25 for regular members and $12.50 for junior members. Subscriptions rates for the *Journal* for libraries would be increased to $35. Consolidated budgets for the AAEA compared with actual expenses and income in 1973 and 1974 were presented and are given in this report (table 1). Projections of income that might result from different dues structures are presented in table 2.

A review of the functions and work of the Investment Committee was undertaken at the suggestion of the president. With the concurrence of the Board, two amendments were proposed to AAEA Bylaws. One replaces the Investment Committee with a Finance Committee; the second creates a new class of senior members as follows.

Amend the Bylaws of the AAEA, Article XII, Section I, *Standing Committees* by deleting the word "Investment" (Committee) and inserting the word "Finance" (Committee). The Finance Committee will be comprised of four (4) persons: one member of the AAEA Executive Board who shall serve as chairperson of the committee, the AAEA Secretary-Treasurer, and two AAEA members who are not members of the Executive Board. The responsibilities of the Finance Committee will be:

(*a*) to annually review the investment portfolio of the AAEA, obtain the assistance of professional counsel as deemed appropriate and make recommendations to the Executive Board;

(*b*) to annually prepare a proposed budget for the AAEA, including review and projections of income and expenditure commitments, and present the proposal to the Executive Board;

(*c*) to assist with special assignments as requested by the President and the Executive Board; and

(*d*) to initiate recommendations for consideration by the Board which are intended to enhance the financial well-being of the AAEA.

Amend the Bylaws of the AAEA, Article II, Membership, Section 2, *Classes of Members*. The membership of the AAEA shall be comprised of four classes (delete the word four and insert the

Table 1. AAEA Consolidated Budgets by Enterprise

	1973 Actual	1974 Actual	1975 Estimate	1976 Budget
Income				
Dues and subscriptions	$ 96,480	$ 97,891	$ 97,900	$141,725
Net sales of old *Journals*	3,416	4,704	3,500	3,500
Page charges	—	—	10,000	22,000
Dividends and interest	7,799	8,593	7,800	8,000
Other	6,206	2,271	2,200	2,200
Total	$113,901	$113,459	$121,400	$177,425
Net Expenses				
Publication of *Journal*	$ 83,603	$103,033	$ 92,700	$100,500
General expenses and Sec.-Treas.	25,288	27,262	36,800	39,400
ABAE—retrospective search	2,498	5,393	15,000	15,000
Postwar literature review	—	—	6,500	?
AAEA Handbook-Directory	—	—	2,000	10,000
IAAE grant	5,000	—	—	5,000
Employment committee	[a]	[a]	[a]	[a]
Total	$116,389	$135,688	$153,000	$169,900

[a] Funded by a grant from the USDL.

Table 2. Projections of Income Based on Alternative Dues and Subscription Rates

	$15 Dues	$25 Dues	$30 Dues
Regular members	3,200 = $48,000	3,000 = $75,000	2,900 = $87,000
Junior members	500 = 2,500	450 = 5,625	450 = 6,750
Subscriptions	2,000 = 45,000	400 = 14,000	400 = 16,000
		1,400 = 44,100	1,300 = 46,800
Sustaining	25 = 2,500	25 = 2,500	25 = 2,500
Corresponding	500	500	500
Total	$98,500	$141,725	$159,550

word five). Add a new class of membership and designate it in Section 2C as follows. Senior members will be entitled to all benefits of AAEA membership and will haye one vote each at any meeting of the AAEA. Senior membership will be open to individuals, upon written request, who are sixty-five years of age or older and have retired from active professional work. Change Section 2c to 2d. Change Section 2d to 2e.

David H. Boyne
Kenneth R. Farrell
John C. Redman
Bernard F. Stanton, *Chairman*

Award Winners

Distinguished Extension Program

Less than ten years. **Frederick J. Smith,** professor, Oregon State University, Marine Economics.

Ten or more years. **John N. Ferris,** professor, Michigan State University, Price Analysis and Outlook.

Distinguished Undergraduate Teaching

Less than ten years. **Lawernce P. Bohl,** associate professor, Purdue University, Agricultural Economics.

Ten or more years. **Kenneth B. Boggs,** professor, University of Missouri, Agricultural Economics.

Outstanding Master's Degree Program

Hal William Evertt, II. "Economics and Environmental Impacts of Forest Resource Development." Purdue University (adviser: William L. Miller).
Larry Leonard Janssen. "Comparative Profit Rates of U.S. Manufacturing Firms by City Size." Oklahoma State University (adviser: Luther G. Tweeten).
Henry Hollis Schaefer. "The Determination of Basis Patterns and the Results of Various Hedging Strategies for Live Cattle and Live Hogs." Iowa State University (adviser: Ronald Raikes).

Outstanding Doctoral Degree Program

David Lynn Forster. "The Effects of Selected Water Pollution Control Rules on the Simulated Behavior of Beef Feedlots, 1975–85." Michigan State University (adviser: Larry J. Connor).
Allen Keith Miedema. "Factor Demands and Particulate Emission Control Regulations: The Case of Steam-Electric Power Plants." North Carolina State University (adviser: Ronald A. Schrimper).
Dennis Ray Lifferth. "An Economic Analysis of Alternative Rail Based Grain Distribution Systems." Iowa State University (adviser: George W. Ladd).

Quality of Research Discovery

M. Chayat, O. D. Forker, and D. I. Padberg. *An Econometric Determination of the Welfare Impact of Giving Bargaining Power to Farmers: A Case Study of the Egg Industry. Search: Agriculture,* Cornell University Agr. Exp. Sta., No. 4, 1974.
Earl O. Heady, and Steven T. Sonka. *American Farm-Size Structure in Relation to Income and Employment Opportunities of Farms, Rural Communities, and Other Sectors* (Card Report 48). Center for Agricultural and Rural Development, Iowa State University, June 1974.

Quality of Communication

Neil E. Harl. *Where There's a Will, Estate Planning.* Cooperative Extension Service, Iowa State University, June 1973.
Harold O. Carter, George M. Briggs, John R. Goss, Maurice L. Peterson, David W. Robinson, Seymour D. Van Gundy, Pran Vohra, and James G. Youde. *A Hungry World: The Challenge to Agriculture.* Division of Agricultural Sciences, University of California-Davis, July 1974.

Publication of Enduring Quality

George E. Brandow. *Interrelations among Demands for Control of Market Supply.* Penn. Agr. Exp. Sta., Bull. 680, Aug. 1961.

Outstanding Journal Article

G. Edward Schuh. "The Exchange Rate and U.S. Agriculture." *Amer. J. Agr. Econ.* 56 (1974):1–13.

AAEA Fellow

See section on Fellow Awards in this issue.

Browning Award

Winner to be announced by the president of the American Society of Agronomy at their fall meeting. Results were not available at the time this issue was sent to press.

Report of the Bibliographical-Retrospective Search Committee

The Bibliographical-Retrospective Search Committee met in Washington, D.C., June 12–13, 1975. Attending the meeting were Allan S. Johnson, ERS, Ivan W. Schmedemann, Texas A&M University, John T. Scott, University of Illinois, R. C. Smith, University of Delaware, J. Edwin Faris, Clemson University, and Isabel Jenkins, ERS. Absent were Marvin G. Julius, Iowa State University and Richard C. McArdle, ERS.

Five recommendations were agreed upon for consideration by the AAEA Board at the August 1975 meeting. (*a*) Cease publication of the *ABAE* at the end of 1975. (*b*) Place the retrospective search (retrieval) system on line not later than January 1, 1976, with increased input to accommodate document receipt. (*c*) Publish in the *Journal* the citations (author and title) entered into the system. (*d*) Execute the memorandum of understanding between the AAEA, National Agricultural Library (NAL), ERS, and Statistical Reporting Service (SRS), which has already been prepared for an indefinite period, with the stipulation that it be reviewed in three years. (*e*) Encourage participation by departments in supplying input to and using output from the Documentation Center.

A letter from Isabel Jenkins is attached to this report. This material serves as partial background information for the remainder of this report (see attachment A).

Publication of the ABAE

Volume 4, number 4, was mailed in June 1975. This completed the 1974 issues. Volume 5, number 1 is expected to be ready for printing about the middle of July and volume 5, number 2 should be ready for submission to the printers by the middle of August. Failure of the initial Boeing retrieval system, plus the lack of expected clerical assistance, account for much of the tardiness in meeting deadlines. By the end of the year, all four issues for 1975 should be published.

The reason for recommending the discontinuation of the *ABAE* is that the committee understood that the printed bibliography would be discontinued when the retrospective search procedure was deemed operational. In addition, publication costs place a considerable financial strain on the AAEA.

Retrospective Search

There are now over 5,000 citations in the file. The search routine can be made operational. Undoubtedly, there will be some difficulties. Now is the time to begin determining if the members of the AAEA will use the retrospective search aspects of the program.

The cost of building the data file (and new citations) is estimated to be approximately $4,500 per year for terminal rental and computer services. The large monthly computer bills early in 1975 resulted from "being on line" for as much as six hours per day and fifteen days per month. The new dual tape cassette terminal using the batch mode should reduce the on-line time to perhaps three hours per month. Most of the citations for volume 5, number 1, were read into the system in 2½ hours at a cost of $64.

The building of the data file does not include the cost of a search. The procedures vary from institution to institution for securing and paying for this service.

Publishing Citations in the Journal

The committee strongly believes that this procedure would be most helpful to the AAEA membership in keeping up with current literature and in promoting interest in retrospective search. These citations would be available to all members in the *Journal*. It would also stimulate participation of more institutions in supplying information for the data base. The cost of this was not estimated by the committee. Perhaps sixty to seventy pages per year would be required in the *Journal* for 2,000 citations closely spaced.

Memorandum of Understanding

The memorandum of understanding, as revised, provides a workable document for retrospective search. The five-year limitation on the files does not apply to the Documentation Center files. Based on 2,000 documents entered into the system for 1976 and discontinuation of the *ABAE*, the cost for building the files for retrospective search would be approximately $14,500 for the AAEA. The cost to ERS would be approximately twice this amount or $28,500. In addition, SRS, would contribute more than $4,000 in computer services and NAL's contribution totals many thousands of dollars.

The committee strongly supports a review at the end of a three-year period. However, we believe that the Documentation Center would operate much more effectively if it did not exist on a year-to-year basis. The commitment is not only for the AAEA but also for each of the cooperating units such as ERS.

Participation by Universities

Less than half of the universities are supplying documents to the Center. Various hypotheses could be advanced for this lack of participation. Increased participation is needed. The committee would consider this as one of their major concerns if the recommendations advanced by the committee are supported by the AAEA.

J. Edwin Faris
Chairman

Attachment A

The Center has completed volume 4; number 4 was received from the printer on June 16 and we are endeavoring to bring volume 5 up-to-date. Number 1 of volume 5 will be ready to mail for printing in about three weeks and number 2 will be mailed about the time of the AAEA's annual meetings.

The failure of the computer system I was using in

the summer of 1974, when for at least three months no productive work was completed, is the reason for being so far behind in the release of the *ABAE*. If I had been able to hire clerical assistance, the Center would have been in a position to complete volume 4 and start volume 5 much sooner. However, I hope to be caught up by the fall of this year and have the last issue of volume 5 off the press in November. This, of course, means the additional expenditure of funds from the AAEA for copy preparation and printing, but some of these funds should have been expended in 1974 and were not.

The cost of using Boeing's TSO system at the beginning of 1975 will be more than offset for the rest of this year by a considerable reduction in processing time. The reason for such high costs in January, February, and March was for inputting of the documents for numbers 3 and 4 of volume 4 directly "on line," in other words, an input of between 15,000 and 20,000 lines of bibliographical data.

Because we have the Texas Instrument's dual tape cassette terminal and are able to transmit in a "batch" mode, the future cost will be much more reasonable. On June 12 and 13 most of the material for one issue of the *ABAE* was read into the TSO system from a data cassette for a total cost of $64. This was the first transaction by this mode so it is difficult to project costs with only one observation. I have, therefore, estimated a monthly expenditure of $100 for the balance of the year for this service, which may prove to be high.

Until the time when publication of the *ABAE* ceases, the cost of the Boeing TSO system and the rental of the terminal will be approximately $5,000, or just about what I estimated last year for the Board of Directors. It is my understanding that at the Board of Directors meeting last August they were aware of some of initial cost to the *AAEA* for the change in operating procedure and the future saving of the cost of publishing, which is and will be higher than the computer system.

The cost to the AAEA for building the data file for publishing volume 5 (1975) is estimated to be $16,405. The cost to ERS will be $22,740. Projections to 1976 for the AAEA are $12,470 for publishing the *ABAE* and $4,470 for not publishing the *ABAE*. Projections to 1976 for ERS are $24,215 for either publishing or not publishing the *ABAE*. If publication ceases with volume 5 and 2000 citations are input into the system, the cost to ERS will be $28,430, reflecting increase in cost of indexing additional documents. If the AAEA signs the Trust Fund Agreement with ERS for employment of clerical assistance, the budget estimates would be adjusted for 1975 and 1976 to reflect this expenditure, in 1976 by $10,000 and in 1975 from the effective date of such employment. It would be my recommendation that publication of the *ABAE* cease with the completion of volume 5 and all resources be applied to enlarging and maintaining the retrieval system.

Isabel Jenkins
Director, American Agricultural Economics Documentation Center

Report of the Committee Appointed to Review the *ABAE* and the Retrospective Literature Search System

The committee recommends the following two major actions: (*a*) the retrospective search system should be continued, strengthened, and more effectively promoted by the AAEA, and (*b*) the printed *ABAE* should be discontinued.

These recommendations are made with some misgivings since we are aware that the issues are complex and opinions are strongly held by AAEA members. The remainder of this report will be an elaboration and a rationale for these recommendations.

Professional growth of its individual members should be the most fundamental concern of any professional association or scholarly society such as AAEA. It is difficult to conceive of any factor more indispensible to professional growth than easy accessibility of the relevant literature. Effective scholarly research and stimulating timely teaching require familiarity with the work of authorities in the field. Some formal mechanism to locate this literature will reduce the search costs and increase the benefits. We, therefore, applaud the efforts of the AAEA, ERS, and the NAL to initiate and support such a formal system.

In considering the problems that will be discussed later in the report, it would be useful to think of the system in terms of inputs and outputs. Inputs refer to the collection of literature citations, their organization and classification into a system, and the preparation of the system file of bibliographic information. The file may then be utilized as the basic input for the two outputs of the current system, the printed *ABAE* and the Information Data Bank which has been made a part of the so-called CAIN file by the NAL and which has been made available to several private companies and marketed by them. Perhaps the two best-known ones are the Lockheed Corporation and System Development Corporation. We will refer to the first output as the *ABAE* and the second as the retrospective information retrieval system.

Continuing and Strengthening the Input File

We believe that it is extremely unlikely that the private sector can or will devote the resources needed to supply an adequate input system. No individual researcher has research interests that are broad enough nor search resources that are

sufficient to prepare a bibliography that could possibly satisfy the needs of all researchers in the field of agricultural economics. Neither would he likely have the time and inclination to make it available to all others who may want it. Business firms that might find it profitable to sell bibliographic information do not usually produce the input information themselves. Perhaps it is too costly to maintain the professional personnel that could adequately evaluate and compile the bibliographic data. As an historical fact, these firms have depended on professional groups like the AAEA and government agencies especially allied to various disciplines to prepare the basic data files. In short, we do not see compelling evidence that the private sector would collect, organize, and prepare the input file of needed bibliographic information. Rather, the input file must be regarded as a "public" good and be produced by some kind of public activity. The joint effort of a professional group such as AAEA and government agencies such as ERS and NAL in such an undertaking seems useful and productive. In sum, we believe that the data bank is needed as an input into some bibliographic output and we see nothing basically wrong with the present collaborative arrangements of AAEA, ERS, and NAL.

It is quite apparent that some basic problems exist in the input system and that these are not unrelated to the problems of marketing the output. We see four major problems: (*a*) the response of those who are assigned to supply titles and abstracts ranges from excellent to poor, but is generally quite inadequate; (*b*) the coverage of the literature is inadequate, especially that part emanating from the universities; (*c*) the output has been consistently behind schedule; and (*d*) the classification scheme by author and major subject area utilized by the *ABAE* has been rather sharply criticized. Some extended comment is warranted on each of these problems.

Information to the committee from the Office of Control Clerk (Ms. Jenkins) in the Documentation Center suggests that only about twenty universities are consistently sending bibliographic information. It is obvious that this is an inadequate input. The literature produced by agencies of the federal government is reported more fully. We believe that AAEA should be responsible for establishing and maintaining an effective reporting system, especially in the universities. Perhaps the Bibliography Committee of the AAEA could assume this responsibility. The cooperators in the various states are key individuals. Close liaison with department chairmen is needed to insure that capable and interested cooperators are assigned in each state, that their assignment is clear, and that they do their jobs. The AAEA must be prepared to follow through on this task and exert pressure for compliance when needed.

Our cursory examination of the *ABAE* revealed that literature published in the states in the form of station bulletins, extension circulars, series published by agricultural economics departments and the like are not getting proportionately included in the system. The reason is probably the dual failure of authors to furnish material to cooperators and of cooperators in the various states to send it on to the Documentation Center. If the cooperator problem is solved, the coverage problem will be mitigated also, providing the cooperators and authors understand that all published literature is eligible for inclusion in the system. A special effort should be made to include citations not likely to be found in other bibliographic files. Cooperators must become aware of the reportable work in the states, outside their own universities as well as within, if the coverage is to be adequate. Research and policy statements of good quality and of interest to agricultural economists are being published by agencies of state governments and sometimes by private firms and should also be included in the system.

It must be recognized that better coverage of published work will increase the load for the Documentation Center which is already overloaded and running far behind schedule. This committee has not thoroughly studied the management and operating procedures of the Center. Perhaps some improvements can be made there. We suggest, however, that authors and cooperators be responsible for abstracting literature and providing key words, tasks now falling partially on the Documentation Center. The AAEA may wish to devote resources now being utilized to publish the *ABAE* (if it is abandoned) to the Documentation Center to facilitate a more current and greater volume of work. The AAEA may also solicit financial support for the Center from other interested parties. Possible candidates would include the Cooperative State Research Service and the Extension Service from the U.S. Department of Agriculture, the Farm Foundation, and business firms which employ agricultural economists. This promotion activity may also be a special charge given to the permanent Bibliography Committee of the AAEA. Donors to the retrieval system should be credited somehow, perhaps in the title of the file or in the citations themselves. Members of the AAEA, particularly, should be aware of its contribution to this effort.

The classification problem has been debated from the very beginning of the bibliography project. The problem persists because the needs of the two component parts of the system are different. The subject and author classification has been quite properly utilized by the printed bibliography, whereas the retrospective literature search file has required the key word retrieval concept. If the *ABAE* is discontinued, the classification problem would seem to be resolved. Most retrieval systems, including the CAIN file, use the key word system. Renewed emphasis should be placed on making

sure that key word descriptors are adequate to facilitate effective search.

Output Issues

The printed *ABAE* is presently in a nonviable situation and we recommend its discontinuance. Despite the fact that a survey of the AAEA membership revealed a strong preference for AAEA sponsorship of a bibliographic service (second only to publication of the *Journal*), private noninstitutional subscriptions to the *ABAE* have never been large and the time trend is down. The secretary of AAEA reports only ten current private subscriptions. The AAEA is being forced to heavily subsidize the *ABAE*. A current survey was made by this committee of university department heads and the following conclusions clearly emerge from the data supplied. The *ABAE* is subscribed to by most departments, but gets very light use, and there seems to be a clear majority opinion that it be discontinued. Similar reactions were encountered in a more informal survey of government agricultural economists.

Two reasons are generally given for the lack of private demand. The *ABAE* is available when needed in the university library and, therefore, a private subscription has little value, and the *ABAE* itself is a poor product, not worth the price asked for it.

The *ABAE* is a publication completely separate from the *Journal*. Its price is not part of membership dues as is the case with the *Journal*. Thus, subscriptions are not mandatory. The rationale for this policy is an appealing one to economists. Subscriptions will be forthcoming only if the subscriber expects the value of the utility derived to be greater than the price. In a perfectly competitive market without externalities, such a rule will result in an optimal allocation of resources to the effort. It is obvious that something is seriously amiss in the real world since private demand is far below supply at the asking price.

Quite apart from the quality issue, however, very few professional associations have been able to market their bibliographies in this fashion. The American Economic Association tried and failed. Eventually the *Journal of Economic Literature* was handled on the same basis as the *American Economic Review;* namely, the publication cost was incorporated into membership dues and all members became involuntary subscribers. This option is available to the AAEA as well. A sizable increase in dues would likely be required, however, and it is our impression from speaking with some members and past officers of the AAEA that such an increase in dues would not be popular and may substantially reduce the membership in the AAEA.

The subscription problem is also related to the quality of the *ABAE* itself. The prevailing opinion seems to be that the *ABAE* is inadequate because it is approximately a year behind schedule and citations are already old when they appear, and the coverage of literature is not complete. Both of these factors could be remedied but this would likely require additional resources. This committee is not at all sure, however, that a current, better-quality *ABAE*, even more vigorously promoted by the AAEA, could be sold to the membership on a take-it-or-leave-it basis.

If the printed *ABAE* were economically feasible, it is possible that a private entrepreneur would invest some risk capital in order to supply it. The input information would be available on tape if the retrieval component of the system is maintained. Such an entrepreneur would have an incentive to design it so that it could be sold. It would be effectively managed, promoted, and marketed. These are activities that a private organization can do much better than a public or quasi-public agency can. We understand, in fact, that the *Bibliography of Agriculture* is now being published by a private firm. Perhaps the same firm would be interested in ours.

We take this position reluctantly, recognizing that supplying the input tapes to a private firm could involve a "subsidy" from AAEA members and the federal government to the private firm. It isn't obvious that the input tape would need to be offered at zero price, however. This would depend on the expected profitability of publication. Officers of the AAEA would need to explore these possibilities as they arise and insist on equitable terms.

Why do we recommend that the *ABAE* be abandoned, but that the retrospective information search system sold commercially as part of the CAIN file be maintained? Doesn't the latter output require the same input costs as the *ABAE* does? The answer seems to be yes and no. The tapes prepared by the Documentation Center are a basic input to both outputs, but there are very substantial additional costs of preparing, printing, and distributing the *ABAE* and little hope of recovering them under present arrangements.

This committee holds strongly to the view that there is great peril for the profession in leaving agricultural economists without any system for acquiring relevant bibliographical information.[1] If there were an alternative mechanism for supplying the information on the CAIN file, we might recommend discontinuing the entire operation of the Documentation Center, etc. We do not see such an alternative for reasons elaborated in the second section. We, therefore, recommend that our component of the CAIN file be left intact and even strengthened along the lines suggested earlier.

[1] We are aware of the *World Agricultural Economics and Rural Sociology Abstracts*, published by the IAAE. The coverage of literature by these abstracts is broad and multidisciplinary and they are not an adequate substitute for the *ABAE*. WAERSA is having problems of its own similar to those discussed in this report. If the respective Boards choose to continue publication, some collaboration should be explored.

Table 2. Responses to Question: "What Was Your Impression Regarding Each of the Following after Your Task Force Experience?"

Abbreviated Subject of Question	Impression					No or Other Response
	Favorable	...	Neutral	...	Unfavorable	
Importance of T.F. charge	36	7	—	2	—	1
Recognition of economics	28	8	6	2	—	2
Competence of T.F. members	31	10	3	—	—	2
Adequacy of travel, other funds	18	6	8	3	3	8
Objectivity of T.F. and report	25	13	4	1	2	1
Promptness of completion	36	6	2	1	—	1
Technical quality of report	22	15	6	2	—	1
Probable impact, nearby	16	11	13	—	1	5
Probable impact, longer term	13	15	12	3	2	1
Overall usefulness of T.F.	20	12	11	—	—	3

Note: Forty-six replies from questionnaire sent to seventy-six agricultural economists who had served on CAST task forces.

the organization is and will remain objective in its operations. Probably correctly, the founders of CAST considered it necessary to have substantial financial support from industry sources in order to have an effective program. CAST structured itself so that formal control of the organization is entirely in the hands of societies and individual members. About one-fourth of CAST's Board consists of scientists employed in industry; these directors were named by societies or elected by individual members. Task forces frequently contain scientists from industry. These facts prove nothing about the objectivity of CAST, but they are frequently cited (sometimes in overstated form) and affect the image of CAST.

In the opinion of the committee, CAST's operations so far have been as objective as any such activity can be expected to be. The CAST leadership seems aware of the objectivity issue and determined to be unbiased. Apparently, supporting and sustaining members have had no influence on task force topics or membership. A very few comments by agricultural economists who served on task forces suggest that some individual industry members of task forces have taken an industry-biased position, but this is neither surprising nor necessarily destructive of the credibility of a task force as a whole. At the other extreme, one agricultural economist considered C. A. Black "paranoid" in his insistence that the task force not make recommendations. In general, agricultural economists with task force experience gave good grades to the objectivity of the task forces.

The task forces have addressed significant questions, a judgment with which agricultural economists serving on task forces agree. The competence of task force members was given high ratings. CAST seems to have adequately recognized agricultural economics; according to C. A. Black, agricultural economics has had more representatives on task forces than any other fields, and table 2 shows that those representatives had a generally good impression of the recognition accorded the economic component of task force problems. Adequacy of travel and other funds for task force use was more frequently downgraded than any other aspect of task force operations; apparently, this shortcoming was most common when CAST was just getting started. (Some respondents gave no opinion on this point because they traveled on foundation or government funds.)

The impact of CAST remains in doubt, which is not surprising for a young organization. That CAST exists seems fairly well known to Congressional committees and federal agencies that might use its services. A task force report on livestock grazing on western federal lands is an example of a study, made for a Congressional committee, that was highly regarded and on which there was some follow-up. Typically, however, evidence of the impact of task force reports is hard to come by. Some knowledgeable persons raise questions as to whether all requests of CAST are seriously intended for constructive action and whether reports always suit the immediate needs of requesters. On the other hand, groups making requests of CAST commonly can be expected to be receiving information (and pressures) from many sources, and it would be extremely difficult to isolate the ultimate

Table 3. Answers to Question: "On Balance, Would You Recommend That AAEA Become a Member of CAST (Annual Cost about $3,000)?"

Reply	Number
Yes	22
No	6
Undecided, no answer	15
No, but yes if cost was not a factor	2
Undecided, but yes if cost was not a factor	1
Total replies	46

impact of information from CAST in most cases. The volume of requests for CAST's services seems as high as might be expected at this stage. Agricultural economists who had served on CAST task forces frequently were uncertain of the impact and usefulness of the reports but generally gave impressions ranging from neutral to favorable.

Pros and Cons on AAEA Membership in CAST

Reasons for AAEA membership in CAST include the following. Many agricultural economists believe that there is an obligation on the profession's part to apply knowledge developed in the field, much of it at public expense, to the resolution of public problems. Though research and education make information available to the public, application to specific questions often is left to others, with the result that it may be unapplied or misapplied. CAST attempts to establish a closer connection between what is known in the agricultural sciences and current, public decision making. No promising alternative seems available to agricultural economists. About 30% of the agricultural economists in the survey expressed an opinion consistent with this general position.

The interdisciplinary nature of CAST and its task forces is a useful development in its own right and necessary for CAST's purposes. CAST needs agricultural economists and agricultural economists need other specialists if most real world policy problems are to be effectively addressed. About 20% of the agricultural economists in the survey mentioned a reason of this kind.

If AAEA were a member of CAST, AAEA would have more assurance that economic judgments were made by economists and would have a voice in CAST policy on both topics considered and means of considering them. Failure of AAEA to join will not completely insulate AAEA from CAST's fortunes, good or bad, because agricultural economists will serve on task forces and because the public image of all professions related to agriculture will be affected to some extent by CAST's operations. For such reasons and perhaps because CAST's use of agricultural economists was thought to imply an obligation for AAEA to join, about one-third of the agricultural economists surveyed gave CAST's use of agricultural economists as a reason for AAEA membership.

Reasons for AAEA not to join CAST include the following. The objectivity issue has already been discussed. This was mentioned as a potential danger to be guarded against even by some agricultural economists who favored AAEA membership.

The membership fee is $3,000–$3,750 annually. About one-third of the surveyed agricultural economists mentioned this, including several who thought AAEA should join CAST.

It may not be in the best long-term interests of any profession having a large stake in independence of thought to become institutionally involved, even indirectly, in controversies in which interest groups take strong positions. Some proponents of this view say that it is a reasoned judgment about how an organization like AAEA can best perform its function over the long pull. Opponents may say that it is an excessively cautious view giving too little weight to being relevant to current issues and seeking to avoid risks that cannot be avoided. This reason for not joining CAST was developed in depth by a few agricultural economists in the survey and probably was among the reasons why some others opposed joining or were undecided.

CAST is viewed by some as a danger to AAEA's tax-exempt status. Membership in CAST and improper activities by CAST could lead to an IRS opinion that a substantial part of AAEA's activities attempted to influence legislation. Neil Harl, lawyer and economist, opposed AAEA membership in CAST for this reason (letter of March 24, 1975 to G. E. Brandow). One other person in the survey of agricultural economists gave this reason against AAEA membership in CAST.

It may be difficult consistently to reconcile the need for promptness in releasing task force reports with the need for careful analysis and good editing. Reservations on this score were expressed by a few agricultural economists in the survey.

Some organizational rivalries may exist or emerge. Apparently the National Academy of Sciences—National Research Council combination and the American Institute of Biological Sciences would prefer to have no CAST. The state university-land grant organization may regard it as in some respects a rival.

Opinions of Agricultural Economists with Task Force Experience on AAEA Membership in CAST

Divided opinions among individuals and ambivalent feelings of individuals characterized the views of surveyed agricultural economists about joining CAST. Table 3 summarizes their views. Advocates of both the "yes" and "no" positions included several well-known and widely experienced agricultural economists. Two respondents said that their "yes" opinions were reversals of earlier positions.

The principal finding of the survey was that those in favor of AAEA membership in CAST considerably outnumbered those opposed but that a few were strongly opposed and roughly one-third were more or less undecided.

Conclusions and Recommendations of the Committee

CAST has made a good start. Its activities to date have been consistent with its avowed purposes. The possibility of industry or sector bias is ever-present but so far successfully avoided.

CAST has yet to work out a permanent arrange-

ment for staff and housing, and it is still developing its policies and methods of operation as it gains experience.

The reasons given in a preceding section for and against AAEA membership in CAST all have some merit. This committee is representative of agricultural economists in that its members weigh the reasons somewhat differently. In particular, one considers the possible loss of tax-exempt status a significant matter, but two think the ease with which CAST has obtained tax-exempt and public foundation status indicates that this reason against membership has lost most of its force.

The committee does not think that it should make a judgment as to whether the cost of CAST membership is decisive. Only the Executive Board has complete information on AAEA's finances and on the alternative uses of its revenue.

Based on what they know now, a majority of the committee would not choose to have AAEA join CAST. The question is closely related to individuals' values about how social (and other) scientists should conduct themselves in dealing with public issues. To a majority of the committee, it appears that the danger of finding the AAEA taking (or being accused of taking) a political position are great enough that CAST membership would be inappropriate for AAEA.

All of the committee consider it unwise for the AAEA Executive Board to decide at the present time in favor of CAST membership. The question is one on which many AAEA members are sensitive. Membership in CAST should be approved only after AAEA members have had ample opportunity to become informed and to express their opinions by balloting. Otherwise, the issue could seriously impair the unity of the AAEA.

An alternative to outright Board approval to disapproval of joining CAST at the present time is to begin a discussion among the membership that might lead to a decision to join CAST. One such procedure would be to have a discussion of CAST at a short-notice rump session at the August meeting or (less desirable) at the business meeting. Depending on the response, the Board could decide at its December meeting whether to poll the membership in the spring of 1976. In light of the majority's view of CAST, the committee does not recommend that the procedure be initiated.

If the Board decides in August to drop consideration of joining CAST, it would seem appropriate to wait three years before studying the question again. The committee recommends that in this case the Board provide for liaison with CAST by appointing an AAEA member for the purpose. The president of AAEA may wish to use the representative for responding to requests from CAST.

G. E. Brandow, *Chairman*
E. N. Castle
W. D. Toussaint

Report of the AAEA Committee on Economic Statistics

The personnel and organization of the Economic Statistics Committee changed considerably in 1974–75. The following members were rotated off the committee: George Judge, University of Illinois; George Tolley, Department of the Treasury; and James Bonnen, Michigan State University. Members added to the committee are: W. Keith Bryant, Cornell University; Gaylord Worden, ERS; Luther Tweeten, Oklahoma State University; and Norman Coats, Ralston Purina Company.

Food and Fiber Data Task Force

The Food and Fiber Data Task Force was disbanded as the committee felt that the task force had made considerable progress in outlining the problem area. As a result of its efforts, certain specific projects are being suggested. These projects are discussed later in this report.

Rural Social and Economic Data Task Force

The Rural Social and Economic Data Task Force continues under the direction of Keith Bryant as chairman. The task force has developed section 8, "Economic and Social Information for Rural America," for the 1975 AAEA annual meeting. Papers will be presented by Bruce Gardner, North Carolina State University, and Raymond Vlasin and Lawrence Libby, Michigan State University. These papers will draw on material developed by the task force in 1973–74. In addition, task force members are serving as reviewers for the papers. From the papers and discussion at the session, the task force will develop plans for future activities.

Raymond Vlasin, a member of the task force, participated in a Federal Statistics Users' Conference panel on criteria for designation and definition of standard consolidated statistical areas proposed by the Office of the Management and Budget.

Coordinating Functions

The committee has served as a coordinating group for the various statistics related activities of the AAEA. Norman Coats was appointed as the AAEA's representative to the Federal Statistics Users' Conference. He has been asked by John Aiken, Executive Secretary of FSUC, to assume chairmanship of FSUC's Committee on Agricultural Statistics. The FSUC's Committee on Agricultural Statistics has been inactive the past several years, and it is hoped that Norman Coats can revitalize this activity with the assistance of the Economic Statistics Committee.

Louis Upchurch, member of the discontinued Food and Fiber Data Task Force, was appointed by President Nielson as the AAEA's representative to

the Bureau of the Census Advisory Committee on Agricultural Statistics.

The joint American Statistical Association-AAEA Committee on Agricultural Statistics did not meet in 1974–75. This committee, which serves as an advisory group to SRS, USDA, meets upon call of SRS. Plans for a meeting in June of 1975 did not materialize. A meeting will likely be held in 1975–76.

Specific Projects

Among the specific projects under consideration by the committee is investigation of alternatives for census-type data in agriculture. An alternative proposed by the American Agribusiness Associates would be examined and compared with present and proposed Census of Agriculture activities. The committee would examine alternatives and predict likely consequences; it would not advocate any particular alternative.

A second proposed project is examination of the training of graduate students relative to data and data systems. It might be possible to suggest improved training methods that would interest graduate students and make them more expert in data systems for the food and fiber industry.

A third proposed project is a study of the benefits versus costs of more and better food and fiber data as well as rural, social, and economic data. There is need for justification of expenditures for improved data that would be useful to budget officials and Congress as well as other officials.

Project Proposal for Approval

The Economic Statistics Committee proposes to help organize and sponsor task forces to study selected economic data series of ERS. These task forces would be jointly organized with ERS to examine the concepts, data inputs, and methods of analysis of specific series. The Economic Statistics Committee and ERS would jointly select the data series to be examined and the task force members. The core membership of the task forces would consist of members of the profession, with additional membership from data suppliers, industry, and other appropriate groups.

The joint task forces would operate in a manner similar to the Farm Income Task Force of 1974. This task force reviewed and made recommendations on concepts and methods of making farm income estimates, including sources of data required to make the estimates.

The task forces would study how the data series are currently constructed, what the series purport to measure, and determine what concepts are not being met by current measures, what new measures or changes in measures are needed, and what data source improvements are needed to develop the measures that will most fully meet the conceptual requirements of economic data series.

The first task force would likely deal with price spreads and marketing margins. This task force would examine this data series in the fall of 1975. The joint task forces would operate at no expense to the AAEA.

W. Keith Bryant
Norman M. Coats
R. J. Hildreth, *Chairman*
Harry C. Trelogan
Luther Tweeten
Quentin M. West
Gaylord E. Worden

Report of the Employment Committee

After a preliminary assessment of the National Employment Registry for Agricultural Economists and discussions with employers and job applicants, we recommend that the computer-based Registry be continued and that further steps be taken to assure its operation. To this end, we have provided the following sets of recommendations.

Since considerably more time was required to develop the National Employment Registry and bring it to a point for evaluating its feasibility, the AAEA, at the recommendation of the Employment Committee, has requested a supplemental Manpower Administration grant. If granted, the funding will provide the AAEA the time—as originally intended—to assess alternative arrangements for providing long-run financial support and to implement the most acceptable plan. A meeting between representatives of the AAEA and the Manpower Administration will be held in early September to discuss the proposal. We recommend the AAEA express its support of this proposal by augmenting Employment Committee representation at the Manpower Administration meeting with AAEA officers or other leaders and contributing $2,000 as a modest amount of support money to be used for the Registry in a manner deemed appropriate by the Board.

In that an overall plan is needed for operating and financing the Registry regardless of whether a supplemental grant is received, we recommend the following priorities. Continued exploration of cooperative efforts between the National Employment Registry for Agricultural Economists and the Registry for Economists, the latter being operated through the Illinois State Employment Service, with funding either (*a*) fully from USDL or (*b*) partially from USDL with supplemental funding from employer groups, foundations, and other interested parties. In the event item (*b*) is pursued, we recommend solicitation of grants or contractual support and institutional membership dues prior to determining the amount of any employer-user fees to be assessed.

Continue exploration of interest by other professional groups in forming cooperative professional

registries. We specifically recommend initial contact by the AAEA president or his representative with follow-up, when appropriate, by the Employment Committee.

If funding cannot be obtained to continue operations at the current level, the AAEA should explore continued cooperation with the Registry for Economists or with a host Agricultural Economics Department (preferably one with Controlled Data Corporation computer capability) to determine where the maximum level of service can be obtained given the resource base. In the event this is implemented, the level of operation could range from a reduced level of applicant input and a maximum of two days per month for job searches to returning to a manual service as used prior to the experimental project, depending on the level of funding. If no financial support is received, the Employment Committee will select a location for storing card decks of the computer programs and manpower data files in the event of future use. If a supplemental grant is received, some modifications will be made in computer programs reflecting operating experience to date. Consequently, if it is contemplated that the *Handbook* and Registry functions will eventually be merged, such additional modification in data collection or output format for the *Handbook* can be done more efficiently while other program modifications are being made.

It is noteworthy that the Registry size is now approaching two-thirds of AAEA membership. Further, the Registry has been described as an "encyclopedia of the profession"—thus providing information to and for the profession in varied areas, including *Handbook* data.

We recommend, for the long run, merger of the *Handbook* into the Registry contingent upon receiving supplemental grant funds; such steps should be taken soon after notification of the grant so that programming related to the *Handbook* can be done simultaneously with the Registry programming changes.

Report of the Extension Affairs Committee

During the past year the business of the AAEA Extension Affairs Committee was conducted by telephone, by correspondence, and by personal discussions between the chairman and the individual committee members during the course of other business. The committee had hoped to meet at least once during the year. However, because of the busy schedules of all of the members this did not work out. A meeting was held during the annual meeting at Columbus, Ohio, with five of the seven members of the committee in attendance.

The major emphasis of the work of the committee centered around increasing the extension contributions to the *Journal* and trying to complete the survey of promotion criteria for extension economists which was begun in 1973.

The analysis of the survey of promotion criteria for extension economists proved to be much more difficult than was anticipated at the time of the last committee report. The further we delved into this analysis the more evident it became that the results would be of questionable value and quite outdated. Several of the committee members indicated that the changes which were being sought when this survey was initiated have been made and they feel that the promotion opportunities for economists working in extension were equal to those for economists working in the other academic areas. Thus, they recommended discontinuance of any further action on this survey. They also recommended that if additional information is needed in this area, a new approach be used so that any results would be of current value to the organization (AAEA). Based upon this recommendation of several members of the committee, we have decided to discontinue any further action on this survey.

The committee under the leadership of Leonard Kyle, Michigan State University, developed a session to be presented as part of the program at the AAEA annual meeting held August 10–13, 1975, at Columbus, Ohio. The title of this session "Agricultural Decision Making under Greater Uncertainty—Issues in Setting Effective Target Prices or Domestic Reserves Policies for Corn and Soybean Production" was prepared and presented August 12.

The four speakers and three discussants on the program pointed out the present cost structure with specific emphasis on the cash cost structure of corn and soybean production and tried to point out anticipated changes which would likely occur in the next few years. They also discussed the effects these cash costs would have on limiting production, on creating demand for building stocks again, as well as the effect that these costs might have on the demand for agricultural land, thus affecting land prices. This session was designed to get audience participation and succeeded very well in accomplishing this end. Approximately 110 people attended this session and the majority of the audience participated actively in the discussion following the main presentations.

The committee feels that this type of session which aims to combine the practical and the theoretical aspects is useful for those economists engaged in extension activities.

In the meeting of the Extension Affairs Committee held in Columbus, the committee members suggested the establishment within the AAEA of a Program Evaluation Committee. The function of such a committee would be to attend the sessions while they were going on at the annual meeting and evaluate them in terms of who and how many attended the meetings, the type of presentations made (that is, were they just reading papers, were they abstractions of papers with discussion, were visuals used, etc.), the adequateness of the meeting

facilities, the audiovisual equipment available, and the audience participation in the subject matter being presented.

Such a committee could be appointed by the president prior to the annual meetings and would be representative of all of the various fields represented by the agricultural economists who are members of the AAEA. They would be asked to prepare a report within the week following the meeting on how well the various sessions were attended and make recommendations for the following year's session based upon interest, participation, and other points which they evaluated. This is simply a suggestion; however, the Extension Affairs Committee felt that such action might improve the quality of some of the presentations at the annual meetings and might thus increase the participation and give them a feeling of what the people really wish to gain by attending the annual meetings.

The committee at the Columbus meeting also discussed the reasons why certain economists engaged in extension activities did not participate in the AAEA. The committee plans to explore the opportunities for securing response from all economists engaged in extension activities, regardless of whether they be members of the AAEA, about their attitudes about the annual meetings (whether they are attending them), their attitudes about the *Journal* and how they use it, their attitudes about the awards programs within the AAEA, what they would like to see on the program for the annual meetings. It was agreed that the committee would attempt to put together a guide document which would enable us to secure this information from the economists employed in extension in all of the fifty states and conduct such a poll and report the results to the president prior to the next annual meeting.

One other item was discussed by the committee. This had to do with means whereby we could encourage more graduate students in the field of agricultural economics to at least acquire a working knowledge of extension activities and extension opportunities.

Respectfully submitted,
Charles Beer, *Chairman*
William Carroll
George L. Casler
Charles D. Covey
Leonard Kyle
Robert Matthes
Charles Rust

Report of the *Handbook-Directory* Committee

The *Handbook-Directory* Committee met in Greensboro at North Carolina A&T State University on March 14, 1975 for the purpose of finalizing plans for the publication of the *Handbook-Directory*.

The following calendar was adopted for the revision of the *Handbook-Directory:* September 1, 1975—questionnaire will be mailed to the membership; April 1, 1976—deadline for the return of completed questionnaire and payment of 1976 membership dues for the *Directory* entrants; April 1–July 31, 1976—preparation of camera-ready copy of the *Handbook-Directory;* August 1, 1976—submission of the camera-ready copy for Part II of the November 1976 issue; and November 1, 1976—*AAEA Handbook-Directory* publication date.

It was decided that the statistical and historical information on AAEA would be revised by the committee. The following items will be limited to three entries each: (*a*) titles of publications, (*b*) honors, and (*c*) memberships in professional associations other than the AAEA. The contents of the directory section will include twenty characteristics of the entrants. Information on sex and ethnic groups and social security numbers will be utilized for statistical purposes only.

The classification scheme for fields of specialization of interest, type of employer, and work activity areas will be the same as that used in the Employment Registry.

The *Handbook-Directory* will be presented in two sections. All *Handbook* materials will be in the first section and the *Directory* will comprise the second section.

The proposed content of the *Handbook-Directory* includes the *Handbook* section—history, constitution, bylaws, objectives, charter members, previous officers, award program and winners, AAEA fellows and annual meetings. The *Directory* section will contain the list of *Directory* entrants, classification of entrants by fields of specialization, geographical classification of entrants, geographical classification of *Journal* subscribers, geographical analysis of entrants and *Journal* subscribers, and a list of sustaining members.

All listings will be done in a typing variation designed to make it more readable. The size of the type will be reduced to conserve space and to minimize cost of publication. The *Directory* entries will also be done in a type variation that will make them more readable when scanning for specific information on the registrants, such as publications, present employment, membership in associations, etc.

The questionnaire has been designed to facilitate coding, keypunching, and statistical analysis. Information collected for the Employment Registry will be analyzed for complementary and supplementary complements to the data bank of the AAEA.

The approved budget for the next issue of the *Handbook-Directory* will be as follows: printing—\$9,066, editorial support—\$1,500, typing—\$900, postage and labor—\$421, for a total of \$11,887.

The committee appreciates the input of the AAEA Directors in the development of this project

and looks forward to the production of a *Handbook-Directory* with enduring quality.

Respectfully submitted,
Joseph Ackerman
Emanuel Melichar
John Redman
Howard F. Robinson, *Chairman*

Report of the Industry Advisory Committee

The AAEA offers a tremendous opportunity for the advancement and dissemination of knowledge on the profession among and between agricultural economists employed by universities, governmental groups, and industry. Every effort needs to be made to ensure that the AAEA serves the needs of all groups of agricultural economists. The industry group was very appreciative of the help and encouragement received by the AAEA in attempting to increase the involvement of agricultural economists employed by industry. The opportunity exists for greatly increased membership and participation from the industry group and efforts to stimulate the interest of this group need to be continued.

The activities of the Industry Advisory Committee this past year were concentrated on industry involvement in the 1975 annual meeting of the AAEA, primarily the organization of the committee-sponsored Invited Papers Session.

The Industry Advisory Committee offers the following recommendations for your consideration: (*a*) that the Invited Papers Session of the annual meeting sponsored by the Industry Advisory Committee be continued in future years; such a session offers the industry group the opportunity to address a topic of interest to them and to communicate their knowledge to a large portion of the profession; (*b*) that a policy of using industry representatives as discussants of annual meeting papers be implemented in those cases where industry experience can contribute to the knowledge of the subject matter; (*c*) that it would be desirable to have an industry banquet at the annual meeting separate from the international banquet and that this recommendation be made at the earliest possible date to the next Industry Advisory Committee; (*d*) that efforts be continued to obtain industry representation on the various committees of the AAEA, and (*e*) that the National Employment Registry for agricultural economists be continued and expanded as a valuable service to industry as well as other members of the profession.

Bernard L. Sanders
Chairman

Report of the Institutional Membership Committee

"Conflict stimulates—Agreement stifles"!
Justification for industry interest in membership in the AAEA and the role of the Institutional Membership Committee was questioned by last year's chairman, and this questioning continues today. Despite what might be interpreted as negative, nonconstructive bickering, however, the differences that exist within the committee give every indication of serving as a catalyst for long-run benefit.

We perceive Institutional Membership as something more than a "donation" to a worthy cause. If firms and foundations are solicited as AAEA members, there should be some identifiable reason for their belonging. Although within the committee, there is less than unanimous agreement as to what the reason(s) should be, there is complete agreement that it(they) should exist, and without it, the committee will be hard pressed to mount a successful "sales" campaign.

Our goal this year was to hold our own (which is an accomplishment in itself) and to add a few new members. This we have done. The plan for next year, contingent upon development of a good "sales package" by the Industry Committee and the Board, is to engage in a vigorous enlistment of new members from all areas of agribusiness and related industries. Toward that end, the chairman has met with the Industry Committee, and by this report, is serving notice that individually and collectively, the members of the Institutional Membership Committee are willing to work with the Board or its designated members, in cooperation with the Industry Committee, to effect a program of identifiable, tangible benefits to institutional members.

Respectfully submitted,
Paul Baumgart
Dale E. Butz
Charles E. Erickson, *Chairman*
Jimmye S. Hillman
Dan. A. Klingenberg
Dean E. McKee

Report of the International Committee

During the past year, a "Review of U.S. Training Related to the Economics of Agriculture of Developing Countries" was completed by the International Committee. This study was conducted pursuant to a resolution adopted by the Executive Board in 1973, and was financed by a $15,000 grant provided by the Rockefeller Foundation. The central objective of this review was to assess the current and future roles of the agricultural economics profession in the United States, to provide needed training and related research in the economics of international agricultural development.

A final report of the review was presented to the Executive Board at its December 1974 meeting in San Francisco. Several broad needs were identified in the study for improving the international component of agricultural economics training. These in-

cluded: (*a*) the broadening of decision making for training programs financed by international assistance agencies by shifting more decisions to those institutions doing the training; (*b*) increase of funds for international agricultural research and education; (*c*) the fostering of professional associations in the developing countries and collaboration and linkages between agricultural economists in those countries and the United States; and (*d*) the developing of greater flexibility within U.S. training institutions to better adapt to the training needs of students from developing countries.

In addition, the report presented six recommendations of actions to be taken by the AAEA. Leadership should be taken to convene a meeting of appropriate officials from agencies, universities, and professional organizations to address fundamental inconsistencies and dilemmas that have been identified in international education. These problems center on the increased demand for training in a time of decreased funding availability and the need for greater flexibility to meet the training requirements of students from developing countries.

A study should be undertaken of the benefits that have derived from international travel grants to support attendance at the conferences of the International Association of Agricultural Economists.

Priority should be given in future meetings of the AAEA to topics on international agricultural development, such as alternative institutional and theoretical formulations for the study of development issues and modern decision-making methods related to the accomplishment of innovations in structures and procedures for training in developing countries and the United States.

Efforts should be made to improve the placement and admission policies and practices of U.S. educational institutions for students from developing countries. Steps should be taken to provide better information on the educational background of entering students from abroad (through up-to-date evaluation of national undergraduate and graduate programs) and to develop better ways to predict student performance in U.S. institutions.

A sample survey should be undertaken of U.S.-trained agricultural economists from developing countries to assess the value and relevance of graduate training received in relationship to the needs in their respective countries.

The AAEA should foster linkages and collaboration with professional associations in developing countries.

The Executive Board approved the first five of these recommendations with the understanding that the International Committee would take the lead in their implementation as time and other commitments permit. No action was taken on the sixth recommendation, as it was felt that this is a major function of the IAAE. Study is now being given by the International Committee to the carrying out of the approved recommendations.

During the year, the International Committee maintained close relationship with the activities of the Research Training Network (RTN) conducted by the Agricultural Development Council with funding provided by the Agency for International Development. The AAEA is represented on the Program Committee of the RTN by a member of the International Committee. The International Committee arranged for a small group of members of the AAEA to review the RTN program, and a report was submitted to AID in October 1974 with a recommendation for the continuation of this effort.

On behalf of the International Committee, I would like to add a special word of appreciation for the outstanding leadership contributions that were made by the former chairman, Lyle Schertz, to the conduct of the review of international training and promotion of other activities of the committee.

Respectfully submitted,
Norman R. Collins, *Chairman*

Report of the Membership Committee

The procedure, explained in last year's report of this committee, of asking individuals to be membership representatives for their institutions, was repeated for 1974 and 1975. These representatives have done an outstanding job and deserve the thanks of the AAEA.

After the 1974 AAEA annual meeting, President Nielson made the excellent suggestion that the Membership Committee be expanded to include specific representation for the 1890 institutions and for industry. David Y. Chen of North Carolina A&T University agreed to serve on the committee to represent the 1890 institutions. He added significantly to our list of contacts by compiling a complete list of agricultural economics, economics, and related departments and their officials. All these officials were contacted and membership representatives designated where appropriate.

Ed Williams of Massey-Ferguson agreed to serve on the committee to represent agricultural economists in industry. Ed has probably been the hardest working member of the committee. During the past year he has compiled a comprehensive list of economists in agriculture-related industries and prepared a solicitation letter to them. Ed also polled industry economists regarding membership in the AAEA and received a number of suggestions as to how the AAEA could be made more interesting and useful to industry economists.

The other members of the committee are William E. Martin, Ted R. Nelson, and Fred O. Sargent representing the Western, Southern, and Northeastern Agricultural Economics Associations, respectively, and John C. Redman, Secretary-

Treasurer of the AAEA. John Redman, of course, carries the primary burden of membership. He faithfully prods each of us each year until we pay our annual dues.

Hopefully, there is a casual relationship between the activities of the committee and growing membership in the AAEA. As John Redman reported, membership increased in all major categories in 1974. A record number of ballots to paid-up members was mailed out this spring. This momentum, combined with the promise of a *Handbook-Directory* in 1976, should maintain membership at a high level during the coming year.

In last year's report, I promised to explore the possibility of developing a brochure which would explain the benefits of membership in the AAEA. The estimated costs turned out to be rather high. In place of the brochure, we used a one-page membership information sheet prepared by John Redman. A supply of these sheets was mailed to each membership representative.

I greatly appreciate the efforts of all the committee members.

Respectfully submitted,
John E. Lee, Jr.
Chairman

Report of the Postwar Literature Review Committee

All seven of the surveys to be included in volume I (*Traditional Agricultural Economics*) are in final form and have been turned over to the Publication of Postwar Literature Committee. Volume I will look like this:

Survey
I. "Farm Management—Production Economics" by Harald R. Jensen (125 pp. of text, 36 pp. of references).
II. "The Analysis of Production Efficiency in Agricultural Marketing—Models, Methods and Progress" by Ben C. French (109 pp. + 98 pp.).
III. "Policy for Commercial Agriculture: A Review of Literature" by G. E. Brandow (118 pp. + 23 pp.).
IV. "Postwar Policies Relating to Trade in Agricultural Products" by D. Gale Johnson (35 pp. + 28 pp.).
V. "Agricultural Price Analysis and Outlook: A Review of Literature" by William G. Tomek and Kenneth L. Robinson (102 pp. + 41 pp.).
VI. "Agricultural Finance and Capital Markets—A Review of Literature since World War II" by John R. Brake and Emanuel Melichar (102 pp. + 32 pp.).
VII. "Technical Change in Agriculture" by Willis Peterson and Yujiro Hayami (65 pp. + 27 pp.).

Volume II (*Quantitative Methods*) is not quite as far along as volume I, but we expect all the surveys to be in final form well before the end of 1975. George Judge of the University of Illinois has provided the leadership and coordination for this volume, as well as preparing one of the reviews. As of July 1, 1975, the status of the volume II surveys is as follows:

Survey
"Introduction" by George Judge (about 8 pp.); now being prepared.
VIII. "On Estimating the Parameters of Economic Relations: A Review" by George G. Judge (about 38 pp. + 12 pp.); now being put in final form.
Commentary on VIII by Richard J. Foote (5 pp. + 2 pp.).
IXA. "On Economic Optimization: A Nontechnical Survey" by Richard H. Day (about 48 pp. + 9 pp.); now being put in final form.
IXB. "Optimization Models in Agricultural and Resource Economics" by Richard H. Day and Edward Sparlin (about 27 pp. + 39 pp.); now being put in final form.
IXC. "Agricultural Production Function Studies"[1] by Roger C. Woodworth (about 22 pp. + 14 pp.); first draft has been evaluated by reviewers, and Roger is now writing this survey in final form; final draft expected around September 1, 1975.
X. "Systems Analysis and Simulation: A Survey of Applications in Agricultural Economics" by S. R. Johnson and Gordon C. Rausser (138 pp. + 63 pp.); final draft in hand.
XI. "Postwar Developments in Agricultural Economics Data"[1] by M. L. Upchurch and others (about 200 pp.); first draft was in handwritten form around June 10. Louis Upchurch anticipated having it typed and in the hands of reviewers by July 1, reviews back between August 1 and August 15. With good luck this might make a final draft possible between September 15 and October 15.

We expect to have before September 1 final drafts of all but IXC and XI. These could be turned over then to the publications committee for initiation of the publication process, in the reasonably certain knowledge that IXC would be available in September, XI in October.

Volume III (*New Fields in Agricultural Economics*) is much further away from being ready for publication. The status of these surveys is as follows:

Survey
XII. "Philosophic Foundations of Agricultural Economic Thought"[1] by Glenn

[1] Title not yet finalized.

Johnson (about 75 pp.); author is well along toward first draft; if needed, a first draft could be available this fall.

XIII. "On Industrial Organization Research"[1] by W. F. Mueller, Peter Helmberger, and William D. Dobson (about 100 pp.); we have been promised a first draft by the end of this summer.

XIV. "Natural Resource Economics" by Emery H. Castle, M. M. Kelso, Joe B. Stevens, and H. H. Stoevener (about 101 pp. + 21 pp.); the first draft has been completed and reviewers' comments are in the hands of the authors; final draft is expected this fall.

XV. "Rural Poverty"[1] by D. Lee Bawden and W. Keith Bryant (about 100 pp.); we are hoping for a first draft before the end of the year.

XVI. "Rural People, Communities, and Regions"; leadership and coordination for this group of surveys have been provided by George S. Tolley.

Introduction by George S. Tolley (about 12 pp.); to be prepared when three prinicpal surveys are nearing final form.

XVIA. "Economic Bases for Growth"[1] by Clark Edwards (about 40 pp.); author was working on review full-time beginning in June, was hoping to have first draft in August or September.

XVIB. "Rural Development: Problems and Prospects for Rural Areas" by Dean Jansma, Hays Gamble, Patrick Madden, and Rex Warland (about 73 pp. + 19 pp.); first draft has been completed and is in hands of reviewers; final draft won't be completed until Survey XVIA is available in draft because of the necessity to articulate XVIB with XVIA; final draft expected by end of year.

XVIC. "Population Distribution: Migration and Settlement Patterns" by Marion Clawson (about 18 pp. + 7 pp.); first draft available but reviews not completed; need to articulate with XVIA makes end of year likely.

XVII. "Agriculture in Economic Development"; leadership for this group of surveys has been provided by Carl Eicher, John Mellor, and G. Edward Schuh.

XVIIA. "Africa" by Carl Eicher and Francis Idachasa (about 75 pp.).

XVIIB. "Asia" by John Mellor (about 75 pp.).

XVIIC. "Latin America" by G. Edward Schuh (about 75 pp.).

As of early June, Eicher, Mellor, and Schuh were expecting to meet in Washington in late June with first drafts. If that expectation was realized, the three scholars were going to combine the three surveys into one chapter before sending the chapter out for review. The end of the year seems to be a possibility with early in 1976 somewhat more likely.

It seems possible but not highly likely that we could have all but two or three of the ten surveys of volume III by the end of the year and could initiate the publication process with the Publications Committee. I am hopeful we can have all of volume III in the hands of that committee by March 1, 1976.

It is also my fervent hope that I can appear before this Board in August 1976 on behalf of the Postwar Literature Review Committee and recommend that the Board vote this ad hoc committee out of existence. That would mean that all three volumes had been turned over to the printers.

Respectfully submitted,
John P. Doll
Peter Helmberger
Glenn L. Johnson
M. M. Kelso
J. Patrick Madden
Lee R. Martin, *Chairman*
Edward R. Tyrchniewicz
M. L. Upchurch

Report of the Committee on Publication of Postwar Literature Review

The committee analyzed alternative methods of publishing the first volume of the Postwar Literature Review. The first alternative would make use of a book publisher. A proposal was received from the University of Kentucky Press. It was determined that the terms of this proposal were about the same as we could expect from other publishers. The second alternative was for the AAEA to be its own publisher. Detailed projections of costs, sales, and the like were made for both alternatives.

The committee recommended that the AAEA act as its own publisher because publication date would be at least six months earlier, the price of the first volume would be $6.00 less to members on a prepublication order, and the AAEA stands a better chance of breaking even under this alternative. The disadvantages of this alternative are the added work load of the Secretary-Treasurer and somewhat higher risk assumed by the AAEA ($6,500 was the maximum loss the AAEA would absorb under the University of Kentucky Press proposal).

E. M. Babb, Jr.
Chairman

Report of the Publication Policy Committee

Most members consider publication the most important activity of the AAEA. Hence, publication policy is a matter of continuing importance. Certain issues raised by the *Journal* Evaluation (S. Smith) Committee are to be discussed at the summer 1975 meetings. The focus will be on the following issues.

Many members feel strongly that the AAEA should publish more and that the volume now published is but a fraction of the volume reasonably expected from a group as large as AAEA. On the other hand, current and past editors have stated that there is no large backlog of publishable manuscripts. Does current publication policy restrain submission of manuscripts demanded by the membership? Does it divert manuscripts to other journals less appropriate as media for agricultural economists? Does it divert empirical reports of general interest?

A continuing concern centers on papers from summer and winter meetings. Some find them the most useful of *Journal* content. Others find little value in them. Many see no reason to exempt invited papers (any more than contributed papers) from common review requirements before publication. Yet to require reviews raises problems in publishing proceedings of program sections. And some see the review of invited papers (e.g., the Fellow's Lecture) as an inappropriate requirement. In short, the publication of summer-winter proceedings papers remains an unsettled issue. And the issue is related to total volume published by the AAEA.

There is strong support for a supplemental publication. However, such a publication is so varied in concept that it is not easy to be sure of what is supported. Some see the new publication as a newsletter. It would contain the AAEA's minutes, News Notes, Announcements, Obituaries, etc. These forty to fifty pages per year of "soft materials" could then be used for publishing more articles, thus reducing the problem of too little volume.

Others with more expansive vision see such a publication as a vehicle for important policy dialogue within the profession. An editor could be chosen for his ability to provoke response to policy positions and propositions on outstanding issues that affect and are affected by the agricultural economy and its participants. Communication within the profession and with others would be encouraged.

Many believe the *Journal* is oriented principally for use of research members of the AAEA. This belief is subject to contention on the basis of content included and content excluded. A considerable policy content can now be found in the *Journal*. Indeed it would be hard to defend mutually exclusive categories of research and policy content. On the other hand, models used in research are seldom described in operational detail. Computer programs and related materials are excluded that would be directly relevant to research members. Some see such content as a part of a new supplemental journal. Clearly the concept of a supplemental journal is far from resolution.

Cost is hardly an issue in the form of publication. It costs about $70 to publish a page of the *Journal*. It costs about $0.01 to reproduce a page of Itek (or similar) material. Publication volume runs about 7,000 copies. Hence, costs are about equal for printing the *Journal* or reproducing another publication. So, costs vary more in response to volume than to form. Timeliness and reference convenience are the issues relevant to form of publication. So also might be quality control.

C. B. Baker, *Chairman*
Glenn Heitz
William Motes

Report of the Resident Instruction Committee

The relatively new Resident Instruction Committee came into being via Board action at the 1973 meetings. During the past two years, we have seen the "phasing out" of the undergraduate contests—speech, essay, and debate. And in accordance with general directives from the Executive Board, the committee has moved to more fully integrate issues relating to resident instruction into the affairs of the AAEA. Also, the committee has attempted to bring the undergraduate activities to a more viable and professional plane and move them to a position of being a more integral part of the annual meetings.

Based on approval from the Board received at the 1974 annual meetings, the Resident Instruction Committee has completed the following activities during the 1974–75 year: (*a*) planned a session relating to resident instruction for the 1975 meetings; (*b*) assisted the officers of the Undergraduate Section in planning and organizing a session for the 1975 meetings (this is the first time for this joint effort with the Undergraduate Section and is one of the changes approved by the Board at the 1974 meetings); and (*c*) coordinated and otherwise facilitated (through periodic announcements, etc.) the submission of papers by undergraduates to the Contributed Papers Section of the 1975 meetings (Board action at the 1974 meetings "reserved" a slot in each contributed paper section for an undergraduate paper if at least one paper of acceptable quality is submitted).

The committee recommends the continuance of these three types of activities. The session on instruction at the 1974 meetings was well attended and well received. Based on feedback to the committee, there is considerable enthusiasm about the upcoming sessions at the 1975 meetings. Many professionals who are interested primarily in teaching say they now have a "home" at the annual meetings.

Submissions by undergraduates in the Contributed Papers Section in this first year were sufficient to justify the continuance of this program. About fifteen papers were submitted by undergraduates, many of excellent quality.

Based on activities this year, the Resident Instruction Committee recommends the following for

action by the Executive Board at the 1975 meetings: approve the continuance of a session on instruction at the annual meetings; approve the continuance of a session to be planned jointly by the officers of the Undergraduate Section with counsel and assistance from the AAEA Resident Instruction Committee; and approve the continuance of the program which reserves a slot in each contributed paper section for an undergraduate's paper of acceptable quality. Further, the Resident Instruction Committee recommends the following charges to the committee for the 1975–76 year: critically evaluate the relative success of the sessions relating to instruction and/or undergraduate activities and the program allowing undergraduates to submit contributed papers as parts of the 1975 annual meetings; evaluate the pros and cons of the idea of an Outstanding Chapter Contest, a recommendation presented to the Board at the 1974 meetings which was not approved, and prepare a recommendation for Board action at the 1975–76 winter meetings; evaluate the relative merit of and need for action by the editor of the *Journal* to give overt and visible support to the submission of papers relating to instructional issues; and evaluate the feasibility of regional debate and public speaking contests as proposed by Bob Duncan and Mike Montgomery, current officers of the Undergraduate Section.

Respectfully submitted,
Charles E. Erickson
Glen Himes
Lonnie Jones
James G. Kendrick
Wayne Purcell, *Chairman*
Jay Townsend
Walter Wills

Report of Visiting Lecturer Committee

Report of Program for 1974–75

The program is confined to those universities offering an undergraduate or master's degree, but not a Ph.D. degree. Association funds are not available for the program, and the schools have limited funds to support the program. The committee attempts to match requests for lectures and the availability of persons to travel to the college or university.

Three institutions indicated a desire for visiting lecturers. When specific individuals were requested, the committee contacted the individuals. Our records show that the following universities were provided with lecturers: North Dakota State University—Leonard W. Schruben, Kansas State University; Southern Illinois University—Neil E. Harl, Iowa State University; and University of Wisconsin-Platteville (arrangements initiated last year)—Dean McKee, Deere and Company. It appears the AAEA owes a debt of deep gratitude to these lecturers, who went to considerable personal inconvenience to give lectures.

Proposal for a New Program

The Visiting Lecturer Committee met on April 28, 1975 at the Farm Foundation offices, Chicago, Illinois, to appraise the Visiting Lecturer Program and to decide whether to recommend its continuation or termination.

Prior to the meeting, the committee surveyed colleges and universities that were eligible for inclusion in the Visiting Lecturer Program and received responses from seventeen institutions. These responses are the basis of our unanimous decision to present to the Board our recommendations for revitalizing the program, procedures to be followed, and a timetable of activity. We respectfully request the Board's approval of the following proposal.

Name of Program. American Agricultural Economics Association Distinguished Visiting Lecturer Program.

Objectives of Program. (*a*) Provide undergraduates and candidates for the master's degree in agricultural economics the opportunity for discussions and exchange of views with distinguished professional persons in the field of agricultural economics. (*b*) Provide opportunity for agricultural economists to demonstrate how the discipline has increased understanding and contributed to the solving of significant public and private issues. (*c*) Provide academic stimulation and increased interest for students to study agricultural economics. (*d*) Strengthen understanding and associations between institutions with limited resources in agricultural economics and other academic institutions, business, and government. (*e*) Provide opportunity for the AAEA to be of service to schools and departments having limited teaching and research resources in agricultural economics.

Procedure. In late winter or early spring the Distinguished Visiting Lecturer Committee will survey eligible institutions regarding subjects they would like to have discussed by visiting lecturers.

In late spring or early summer, the committee will review the responses received from eligible institutions and list subject matter categories for which lecturers are desired by these institutions. The committee will then publicize these needs to the profession and receive applications from individuals interested in being named a Distinguished Visiting Lecturer in the respective subject matter areas.

From the applicants the committee will recommend to the Board of the AAEA individuals to be named Distinguished Visiting Lecturer for the coming academic year. The committee may recommend

that the Board invite specific individuals to become a Distinguished Visiting Lecturer in order to provide adequate coverage of subject matter areas and to obtain individuals in locations that may minimize transportation costs to the eligible institutions and thereby facilitate the program.

The Board of the AAEA will announce the names of three to six Distinguished Visiting Lecturers for the year at the AAEA's annual meeting in August.

Following announcement of the Distinguished Visiting Lecturers and lecture topics, representatives of the eligible institutions will directly contact Distinguished Visiting Lecturers of their choice to visit their institution and make tentative arrangements for visits. These contacts should be made prior to October 1.

Distinguished Visiting Lecturers will make their visits and presentations in the period from October 1 through July 1.

The Distinguished Visiting Lecturer Committee will continually evaluate the program and recommend changes as required.

The Distinguished Visiting Lecturers will be given certificates of appreciation during the awards program at the AAEA's annual meeting in August. They will also be given prominent recognition in the Proceedings issue of the *Journal*.

Explanations and Definitions. Institutions eligible for services of the Distinguished Visiting Lecturers are those providing a concentration in agricultural economics or a related area such as agribusiness, in the undergraduate or master's level curricula. At present, institutions having a Ph.D. program are excluded on the grounds that students in these universities have a greater opportunity to be exposed to a broad range of professional agricultural economists. However, the committee envisions that the program may eventually be expanded to include all institutions, including those having a Ph.D. program.

The individual selected as a Distinguished Visiting Lecturer should show evidence of professional distinction by publications and national prominence. Naturally, individuals selected should have something to say about the subject and be able to communicate with undergraduates. No one will be eligible to serve as a Distinguished Visiting Lecturer for two successive years.

The individuals selected will be expected to spend at least one day lecturing and counselling at the host institution and visit at least three eligible institutions during the academic year.

We recommend that the AAEA budget $2,000 for the program in the 1976–77 academic year. This money will be held by the AAEA secretary-treasurer for use by the Distinguished Visiting Lecturers. These funds will be used only for travel expenses. The AAEA is expected to contribute a minimum of $50 toward each visit made by a Distinguished Visiting Lecturer. Additional amounts are expected to be provided to the Distinguished Visiting Lecturer by his own department and by the eligible institution. Sharing arrangements for expenses will vary for each trip, but we believe "seed money" provided by the AAEA will help the host department or division obtain funds from its own university. The committee also believes that foundation support for the program should be explored.

It is our opinion that the AAEA will benefit from this activity. Prospective benefits include building of professional relationships and increased membership. Moreover, the number of sustaining members may increase if funds are earmarked for this purpose.

The membership of the Distinguished Visiting Lecturer Committee should be expanded from the present four individuals to five or seven. The majority of the committee members should be selected from the faculties of eligible universities, and the remaining members should be individuals who meet the criteria for Distinguished Visiting Lecturers. In time, the committee should include some individuals who have served as a Distinguished Visiting Lecturer.

The committee recommends that the basic program begin with the 1976–77 academic year. This means that the committee must be named in time for it to begin work in the late winter or early spring of 1976. The first group of Distinguished Visiting Lecturers will be named at the annual meeting in August 1976. The present program should be continued for the 1975–76 academic year.

William McD. Herr
R. J. Hildreth, *Chairman*
James S. Wehrly
T. T. Williams

Work of the National Bureau of Economic Research in 1974

Research Projects

The National Bureau's research program during the year included more than 100 individual projects that were being conducted by members of the staff. The projects were in the following general areas: measurement of economic and social performance, including national income, productivity, employment, price levels, and business cycles; financial and industrial institutions and processes and the effects of inflation; urban and regional studies; international trade and economic development; human behavior and social institutions, including education and earnings, legal institutions and law enforcement, health and health care, population and family economics; and research on computer-based quantitative methods. Staff reports on respective projects appear in the National Bureau's 54th Annual Report, September 1974, which may be obtained from the Bureau upon request.

During 1974, research operations got underway at the new office, NBER-West, Palo Alto, California, under the codirectorship of Victor Fuchs and Sherman Maisel. By the end of the year some thirty staff members and associates were at the new facility, many having transferred from the New York office. The National Bureau also opened an office in Washington, D.C. to accommodate ten staff members and associates who are conducting research and conference programs in that area.

At the request of the National Science Foundation, the National Bureau undertook in 1974 a new activity to assist in the development of a United States-USSR Program on Scientific and Technical Cooperation. The Bureau is helping plan and coordinate the program in fields of econometric modeling, economic programming, and computer analysis applied to the economics and management of large systems.

Research Conferences

During 1974, conferences were held on research in income and wealth, price behavior, the economics of urban spatial structure, the role of health insurance in the health services, and economic analysis of political behavior. Conferences were planned on causes and economic effects of population change in less developed countries and on low income labor markets.

The Conference on the Computer in Economic and Social Research held five workshops on large-scale urban simulation models; documentation of large machine readable statistical data sets; household theory for consumer expenditure data; stochastic control theory; and computer techniques in data analysis. In addition, the conference on Econometrics and Mathematical Economics operated eleven ongoing working groups at various host universities. Latin American computer workshops were held in Rio de Janeiro, Bogata, Mexico City, and San Paulo (February 1975).

The project on Foreign Trade Regimes and Economic Development held a workshop in Manila and another was planned for April 1975 in Rio de Janeiro. Two special conferences were held on the West Coast—one on regional stock exchanges in a central market system and another on international trade, finance, and development of Pacific basin countries.

Publications

A new quarterly journal, *Explorations in Economic Research,* was inaugurated, and the first two numbers were issued in September and December 1974. This journal is designed to present staff research reports of the type that were formerly published separately as occasional or technical papers. In addition to major articles, the journal will also regularly feature a summary of the ASA-NBER Business Outlook Survey.

The National Bureau also published four numbers of volume 3 of *Annals of Economic and Social Measurement,* a journal of computers, information retrieval, and research methodology.

Books published in 1974 included eight staff research reports and four conference volumes. In December 1974, thirteen books were in press.

Harold G. Halcrow
Representative of the AAEA to the NBER

Minutes

Minutes of the Executive Board Meeting, San Francisco

The meeting was called to order by President James Nielson at 8:10 a.m. December 27, 1974.

Present: Voting members:
Nielson, Farrell, Robinson, Tefertiller, Heitz, Bonnen, Stanton, Baker.
Member ex officio:
Redman, Tomek, Polopolus.
Guests:
Boyne, McCormick, Schertz, Collins, Martin, Harding, Ackerman.

1. Nielson reviewed the agenda and asked for suggestions.

2. Baker moved the approval of the minutes of the summer meeting of the Executive Board at College Station. Seconded. Passed.

3. Nielson reported on committee assignments, emphasizing the desire to place new people on committees.

4. Redman reported briefly on the status of the membership, financial condition, and investments of the AAEA.

5. Acting on request for guidelines from the Audit Committee, Stanton moved that the Audit Committee secure each year the services of a certified public accountant licensed in Kentucky to audit the financial records of the AAEA. Seconded. Passed.

6. Stanton gave a brief preliminary report for the Finance Committee.

7. Tomek reported briefly on plans and procedures involving his editorship of the AJAE.

8. Baker presented a report of the Publications Policy Committee and moved that the Proceedings continue to be printed in the present *Journal* series. The only papers guaranteed publication not subject to established reviewing procedure would be the Presidential Address, the Fellow's Lecture, and a set of papers invited by the President, the number to be reviewed annually by the Board. Fifty-word abstracts of all other invited and contributed papers at the annual meetings to be published in the *Journal* without jeopardizing later acceptance in their entirety subject to regular review. This action is not intended to detract from fulfilling the objectives of the *Journal*. It does intend, however, to compel the President and the Board at least annually to help assure that practical financial limitations are observed. Seconded. Passed.

Tefertiller moved that issues involving needs, interests, content, frequency costs, etc. of publishing "soft material" in a separate publication be communicated to the membership through a mailing or at the annual meeting. Seconded. Passed.

9. Robinson reported for the *Handbook-Directory* Committee indicating the changes to be made in the next *Handbook* scheduled for publication in 1976 and moved that the time schedule be adopted. Seconded. Passed.

10. Schertz and Collins presented a report for the International Committee. Stanton moved that the International Committee be commended for the excellent job performed. Seconded. Passed.

Stanton moved that AAEA through the International Committee should explore and attempt to establish directions which will resolve fundamental inconsistencies in international education, namely increasing need versus declining funding and greater need for flexibility in meeting needs of students versus limited funding. Seconded. Passed.

Baker moved that AAEA encourage the International Committee to evaluate the benefits which have been derived from the international travel grants awarded by the AAEA with particular reference to the contribution made to international education. Seconded. Passed.

Baker moved that the President and Executive Board, as the program committee for the annual meeting, give high priority to organizing sessions on appropriate topics in international education. Seconded. Passed.

Farrell moved that the International Committee assume the responsibility of obtaining funding to evaluate ways of monitoring changes in education abroad in agricultural economics and to develop techniques for predicting performance of students applying to U.S. universities. Seconded. Passed.

Baker moved that the International Committee be encouraged to survey a sample of agricultural economists in other countries who have obtained part or all their graduate education in the United States to obtain an evaluation of their U.S. education. Seconded. Passed.

Heitz moved that the Board express appreciation to the International Committee for its efforts and generally support its recommendations and encourage its efforts, subject to appropriate clearance with the Board whenever money, manpower, or policy questions arise. Seconded. Passed.

11. Farrell moved that AAEA provide $5,000 for assistance of young American agricultural economists to attend the meeting of the International Association of Agricultural Economists to be held in July 1976 in Nairobi, Kenya. Seconded. Passed.

12. Polopolus reported as outgoing editor of the *Journal*.

13. Farrell presented a revised memorandum of understanding between the AAEA and the Economic Research Service, National Agricultural Library, and Statistical Reporting Service of the U.S. Department of Agriculture concerning the Bibliographical-Retrospective Search activity. Af-

ter discussion, it was agreed that no action be taken at this meeting. The Bibliographical-Retrospective Search Committee is charged with the responsibility of further development of the revised memorandum.

14. Martin reported for the Committee on Postwar Literature Review indicating that five of the seven papers planned for volume I were ready and are being sent to Redman for publication. Stanton moved that AAEA proceed toward publication of volume I and that a special committee be appointed to work with the Literature Review Committee and the Secretary-Treasurer in the development of publication plans, marketing strategy, pricing, etc. Seconded. Passed.

15. Stanton moved that AAEA accept the invitation of Virginia Polytechnic Institute and State University to meet there on August 6–9, 1978. Seconded. Passed.

16. Stanton moved that AAEA accept the invitation of Western Agricultural Economics Association for a joint meeting in San Diego, July 31–August 3, 1977. Seconded. Passed.

17. The financial report of the annual meeting held at Texas A&M University last August was received. Baker moved that the books be closed for that meeting and that the Secretary-Treasurer pay the charges previously agreed upon for the Employment Committee and the Bibliographical-Retrospective Search Committee. Seconded. Passed.

18. Baker moved to accept the Resident Instruction Committee's recommendation for the AAEA to provide a slot for each contributed paper topical area for a qualified paper by an undergraduate and that it be subjected to the same review procedures followed for other papers. Seconded. Passed.

19. Boyne and McCormick reported on plans for 1975 meeting at Ohio State University, emphasizing the uncertainty due to external factors and asked for direction on some activities. Farrell moved that the employment service at Ohio be a part of the Employment Committee's activities, that they be authorized to spend up to $250 for telephone hookup, and that it be charged to the Employment Committee account. Seconded. Passed.

Stanton moved that the registration fees for the Summer 1975 meetings be set at $15.00 for single persons and $20.00 for families. Seconded. Motion failed.

Baker moved that the registration fees for the Summer 1975 meetings be set at $15.00 for single persons and $18.00 for families. Seconded. Passed.

Stanton moved to advance $2,000 to Ohio State University should it be needed for the 1975 meetings. Seconded. Passed.

20. Harding presented a proposal from the Agency for International Development that the AAEA assume the responsibility to recruit and manage short-term personnel for AID in order to improve the capability of the developing countries to obtain suitable personnel. Consensus was that a professional society like the AAEA could not accept the responsibility for such a recruitment and management function. However, it was the consensus that AAEA may be interested in exploring the possibility of an arrangement whereby the National Registry of Agricultural Economists would provide resumes for AID's use. No action was taken.

21. Stanton moved the approval of the recommendation of the report by the Publication Policy Committee that space be reserved in the *Journal* for scholarly review articles. Seconded. Passed.

22. Stanton presented the report for the special Finance Committee. After considerable discussion on objectives and commitments of the AAEA to individual activities and enterprises and the projected deficits faced, Stanton moved on behalf of the Finance Committee that the Executive Board propose to the membership for approval next summer the following dues structure to be implemented on January 1, 1976: regular members, $25.00; junior members, $12.50; subscriptions, $35.00; institutional members, $100.00. Seconded. Passed.

Stanton moved on behalf of the Finance Committee that a uniform page charge of $40.00 per printed page be instituted for the *Journal* for all manuscripts published, effective with August 1975 issue. The editors are to be authorized to make the following exceptions in assessing page charges: presidential address, fellow's lecture, papers invited by the president and editors (the number to be reviewed annually by the Board), student papers not supported by department-sponsored projects or programs, papers accepted from individuals who have no sponsoring institution to cover the page charge and book reviews. Seconded. Passed.

23. Nielson reviewed the tentative program for the summer 1975 meeting. Stanton moved that the president use his discretion in inviting those people who must have travel expenses paid. Seconded. Passed.

Adjourned at 4:00 p.m., December 29, 1974.

Respectfully submitted,
John C. Redman
Secretary-Treasurer

Minutes of the Executive Board Meeting, Columbus

The meeting was called to order by the President James Nielson at 8:30 a.m. August 9, 1975.

Present: Voting members:
Nielson, Stanton, Robinson, Farrell, Baker, Heitz, Bonnen.
Members ex officio:
Redman, Tomek, Meenen, Ball.
Guests:
Barr, Raup, McCormick, Boyne, Gardner, Hildreth, Himes, Mather, Ackerman, Martin, Babb, Harl.

1. McCormick reported on local arrangements and indicated that 959 had preregistered.

2. Nielson reviewed the agenda, indicating that a number of reports would be received for later action.

3. Stanton moved the minutes of the winter meeting of the Executive Board at San Francisco be approved as distributed. Seconded. Passed.

4. Nielson read the Tellers Committee report, indicating that Kenneth R. Farrell will be the new president-elect and Wallace Barr and Philip M. Raup will be the new directors.

5. Gardner reported as chairman of a committee to review the bibliographical-retrospective search activities of the AAEA.

6. Redman distributed and reviewed the Secretary-Treasurer's report and the Investment Committee report which will be presented at the general business session of the AAEA.

7. Nielson distributed the report of the Audit Committee which indicated that a certified public accountant had audited the accounts and found them in proper order.

8. Nielson distributed the report of the Membership Committee.

9. Tomek summarized the Editor's report which will be presented at the general business session. He reported that permission to reprint from the now copyrighted *Journal* would be contingent on obtaining the author's permission and recognizing the *Journal* appropriately.

10. The report of the committee to study the feasibility of AAEA joining the Council for Agricultural Science and Technology (CAST) was thoroughly discussed. Stanton moved that AAEA not join CAST as a professional society at this time. Seconded. Passed.

11. Hildreth reported as chairman of the Economics Statistics Committee and as the chairman of the Visiting Lecturer Committee.

12. Himes reported for the Resident Instruction Committee.

13. Mather and Ackerman reported for the Employment Committee.

14. Martin reported for the Postwar Literature Review Committee, indicating that the manuscript for volume I was completed May 1, volume II would be completed this fall, and volume III would be completed by next summer.

15. Babb reported for an ad hoc committee on publication plans for the Postwar Literature Review.

Board recessed at 4:55 p.m.

Reconvened on August 10 at 8:20 a.m.

Present: Voting members:
Nielson, Stanton, Robinson, Farrell, Baker, Heitz, Tefertiller, Bonnen.
Members ex officio:
Redman, Tomek, Meenen, Ball.
Guests:
Raup, Barr, Holt, Malone.

16. Regarding the report of the Resident Instruction Committee, Stanton moved to approve the continuance of a session at the annual meeting planned jointly by the officers of the Undergraduate Section with counsel and assistance from the Resident Instruction Committee but not to be included as a part of the invited papers sessions, as these papers must be reviewed before *Journal* publication. Seconded. Passed.

17. Tefertiller moved to accept the recommendations of the Economic Statistics Committee which will investigate alternatives for census type data in agriculture, examine the training of graduate students relative to data and data systems, study the benefits versus costs of improved food and fiber data as well as rural social and economic data, and help to organize task forces to study selected economic data series of the ERS. Seconded. Passed.

18. Proposals on visiting lecturers were discussed. The consensus was that the general idea and objectives of the proposals were good. The Board encouraged the committee to work toward development of means to provide visiting lecturers without special funds and without special AAEA designation. No action taken.

19. Holt and Malone reviewed the arrangement for the 1976 summer meeting to be held at Pennsylvania State University, August 15–18.

20. Robinson reported for the *Handbook-Directory* Committee, indicating that the questionnaire would go out in Fall 1975 and the deadline for return and payment of 1976 dues would be April 1, 1976. The questionnaire will be designed so a statistical profile of the profession can be obtained. The scheduled date for publication is November 1976 as part II of the *Journal*.

21. Regarding the publication plans for the Postwar Literature Review, Farrell moved that selected commercial and university publishers be contacted for the purpose of securing written bids for publication of volume I of Postwar Literature Review, that such bids contain sufficient detailed information that the Board could take final action during or before the meeting of the Board in December 1975. Seconded. Passed.

22. Stanton moved that AAEA cease publishing the *American Bibliography of Agricultural Economics* at the end of volume IV, No. 4 (November 1974), that all subscriptions beyond 1974 be refunded and that all financial obligations and commitments concerning the *ABAE* be cancelled or honored as appropriate. Seconded. Passed.

23. Stanton moved that the AAEA place the retrospective search system on line (modified batch) with increased input to accommodate material received from all sources of agricultural economic literature. Seconded. Passed.

24. Farrell moved to encourage participation by departments and agencies in supplying input to and using output from the Documentation Center and to request the Bibliographical-Retrospective Search

Committee to develop and implement appropriate procedures to achieve that objective. Seconded. Passed.

25. Concerning the Gardner report on *ABAE*, Stanton moved the remaining recommendation not acted upon (to strengthen the retrospective search system) be referred to the Bibliographical-Retrospective Search Committee to develop procedures to strengthen the demand for the retrieval system. Seconded. Passed.

26. Stanton moved that the Executive Board recommend to the membership that the Standing Committee on "Investment" be changed to "Finance" (Bylaw Article XII, Section 1). Seconded. Passed. This committee shall be comprised of four persons; a member of the AAEA Board who shall serve as chairperson, the AAEA Secretary-Treasurer, and two AAEA members who are not members of the Board, who shall review annually the investment portfolio, prepare proposed budget, and initiate suggestions which will enhance the financial well-being of the AAEA.

27. Stanton moved that Bylaws, Article II, Section 2, be amended to read "the membership of the Association shall be comprised of five classes"; add a new class of membership and designate it as Section 2c as follows. "Senior members shall be entitled to all benefits of Association membership and shall have one vote each at any meeting of the Association. Senior membership shall be open to individuals upon written request who are sixty-five years of age or older and have retired from active professional work." Change Section "2c" to "2d" and "2d" to "2e". Seconded. Passed.

28. Stanton moved that senior membership dues be the same as the junior membership. Seconded. Passed.

29. Stanton reported as chairman of the Finance Committee and moved that the Executive Board recommend to the membership that the annual membership dues for regular members and junior members be increased to $25.00 and $12.50, respectively, effective with 1976 dues. Seconded. Passed.

30. Stanton moved that the annual subscription rate be increased to $35.00, effective with 1976 subscriptions and that the annual institutional membership remain at $100 per year. Seconded. Passed.

31. Stanton, as chairman of Finance Committee, assisted by Secretary-Treasurer Redman, submitted a budget for 1976, subject to the membership approval of dues increase. After considerable discussion, Tefertiller moved that the budget be approved, subject to membership approval of dues increase. Seconded. Passed. Board recessed at 5:30 p.m.

Board reconvened on August 13 at 11:15 a.m. with President James Bonnen presiding.

Present: Voting members:
Bonnen, Nielson, Heitz, Stanton, Robinson, Raup, Barr, Farrell.
Members ex officio:
Redman, Tomek, Meenen.
Guests:
Mather, Ackerman, Janssen.

32. With regard to specific request for guidance in hosting future annual meetings, the Executive Board expressed its general desire not to tell a host institution what it can do. It was pointed out that AAEA has a resolution against the practice of using the AAEA for advertising or promotional purposes. Also, no political office seeker should be sought to speak.

33. Nielson moved that the *Journal* publish the author and title of publication being entered into the retrieval system as recommended by the Bibliographical-Retrospective Search Committee. Seconded. Passed.

34. Stanton moved that the president of AAEA be authorized to negotiate the general memorandum of agreement or understanding and the memorandum of agreement to establish a trust account with ERS to support the retrospective search activity. Seconded. Passed.

35. Mather, Ackerman, Harsh, and Janssen presented a set of recommendations concerning the future of the computer-based Employment Registry. Barr moved that the Employment Committee be augmented with AAEA officers or other leaders for the purpose of meeting with the Manpower Administration to discuss matters related to the Registry. Seconded. Passed.

Farrell moved that all recommendations except one dealing with continued exploration of interest by other professional groups in forming cooperative professional registries, be deferred until discussions are held with the U.S. Department of Labor. Seconded. Passed.

36. Farrell agreed to explore the possibility of a historical study of AAEA.

37. Bonnen reviewed the program for the winter meeting in Dallas. Board adjourned at 1:45 p.m.

Respectfully submitted,
John C. Redman
Secretary-Treasurer

Minutes of the Annual Business Meeting, Columbus

The 64th annual meeting was called to order by President Nielson at 11:00 a.m.

1. President Nielson presented for approval the minutes of the annual business meeting held at College Station, Texas, August 20, 1974, as published in the proceedings issue of the *Journal*. Motion made to accept. Seconded. Passed.

2. Nielson announced officially the results of the election. Kenneth R. Farrell was elected president-elect and Wallace Barr and Philip M. Raup were elected directors.

3. Redman presented the Secretary-Treasurer's report for fiscal year, January 1, 1974 through December 31, 1974.

4. Redman presented the Investment Committee report for fiscal year, January 1, 1974 through December 31, 1974.

5. Nielson presented the Audit Committee report for 1974.

6. Tomek reported as editor of the *Journal*.

7. Nielson highlighted the activities of the Executive Board. (*a*) On the bibliographical-retrospective search activity, Gardner reported as chairman of a committee established by a motion at the 1974 business meeting to review the activity. The committee recommended that the AAEA discontinue publishing the *ABAE* immediately and that the retrospective search be continued and strengthened. The same recommendation had been made to the Board by the Bibliographical-Retrospective Search Committee chaired by Faris. Nielson reported that the Executive Board had voted to discontinue the *ABAE* and place the literature on line beginning in 1976. Trelogan moved that AAEA explore the feasibility of combining our efforts with WAERSA and other international abstracting or retrieval systems. Seconded. Passed. (*b*) The AAEA reviewed ways to finance and improve the use of the Employment Service and the National Employment Registry of Agricultural Economists. (*c*) The Postwar Literature Review Committee has submitted volume I for publication and expects volume II to be completed by end of 1975 and volume III by end of 1976. (*d*) The *Handbook-Directory* will be published again in 1976. (*e*) The Board voted not to join the Council on Agricultural Science and Technology (CAST) at this time, but the AAEA will continue to work with CAST on an informal basis. (*f*) The president exerted special effort this year to get more involvement of industry economists in the AAEA's activities, including scheduled spots on the annual meeting program. (*g*) Student contests at the annual meeting were discontinued at the recommendation of a special review committee and the Resident Instruction Committee. A program for student participation in special sessions and through the contributed paper sessions of the annual meeting have been scheduled. The Resident Instruction Committee and the Board are seeking additional alternatives to stimulate student interest and involvement. (*h*) The Economic Statistics Committee has participated actively in exploring ways to improve the quality of federal statistics for the agricultural and food industry.

8. Stanton moved to amend the Bylaws, Article XII, Section 1 by deleting the word "Investment" and inserting the word "Finance." Seconded. Passed.

9. Stanton moved that annual dues for regular members be increased from $15.00 to $25.00 and for junior members be increased from $5.00 to $12.50, effective for the year 1976. A member moved that classes of membership be classed according to those who want the *Journal* and those who don't. Motion died for lack of second. Scott moved to amend the motion that dues be raised to $30.00 for regular members and $15.00 for junior members so the activities of AAEA can be financed adequately. Seconded. Motion lost by vote of 88 to 53. Original motion passed overwhelmingly.

10. Farrell presented a resolution thanking Ohio State University for hosting the meeting with the request that the resolution be printed in the *Journal* and copies sent to appropriate personnel of the university.

11. Nielson announced the following dates and sites of future AAEA meetings: August 15–18, 1976 at Pennsylvania State University; July 31–August 3, 1977 at San Diego; and August 6–9, 1978 at Virginia Polytechnic Institute and State University.

12. Nielson thanked Redman for his assistance as Secretary-Treasurer, Tomek and Polopolus and Langham as editors, retiring Board members Tefertiller and Baker, and those members who served on various committees and turned the chair over to James T. Bonnen who became president.

13. Bonnen announced appointment of a nominating committee of which James Nielson will be chairman.

14. Bonnen issued an invitation for suggestions, comments, etc. from the membership.

The meeting adjourned at 12:30 p.m.

Respectfully submitted,
John C. Redman
Secretary-Treasurer

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Circulation:		
Sales through dealers, carriers, etc.	(*a*) None	(*b*) None
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Total distribution	(*a*) 6,126	(*b*) 6,126
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Total	(*a*) 7,000	(*b*) 7,000

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More and more agricultural economists are using the CAIN file through the DIALOG system of Lockheed and other marketers where they are available. The search costs are modest and are incurred only by those who want the output. Printouts of citations can be obtained within a few days. The total number of universities in the United States that have direct access to the CAIN file is twenty-nine, however, and land grant universities would be even fewer. There is obviously a need for a promotion effort to increase this number since the cost of these services is not relatively large.

We would argue that there is presently serious underinvestment in bibliographic retrieval by agricultural economists. Ignorance about the existence of the CAIN file and how to use it is pervasive in the profession. The AAEA should take on the responsibility of doing something about this situation. We recommend that the AAEA devote a session to this topic at an annual meeting. The importance of bibliographic search and the capabilities of available systems should be thoroughly discussed. We are aware that demonstration booths showing equipment and printouts have been set up at past meetings, but it is our impression that they have gone largely unnoticed by the profession. An intensified effort is needed now. We would expect that the results would be beneficial for two reasons. More agricultural economists would see the need for and know how to conduct an information search and it is our belief that this activity would increase. AAEA members would understand the commitment of the AAEA itself to effective bibliographical information retrieval.

Delworth Gardner
Linley Juers
William Park
James Rhodes

Report on AAEA Membership in CAST

This is the report of a three-man committee set up by President James Nielson to study the question of whether AAEA should become a member of the Council for Agricultural Science and Technology (CAST).

CAST grew out of an opinion at the end of the 1960s that agricultural science societies should form an organization to bring the knowledge of agricultural scientists to bear on current public questions (e.g., the relation of food production and processing to environmental protection and food safety). AAEA was invited to join in forming such an organization. The board considered the question at the 1971 annual meeting and voted to "maintain a liaison with the Council but at this time not become affiliated" (Board minutes). Sufficient support was provided by other societies to launch CAST officially in January 1973. As of June 1975, fifteen societies were members of CAST (table 1). One other society was polling its membership on CAST membership.

Table 1. Member Societies of CAST, June 1975

American Forage and Grassland Council
American Meteorological Society
American Society for Horticultural Science
American Society of Agricultural Engineers
American Society of Agronomy
American Society of Animal Science
Association of Official Seed Analysts
Council for Soil Testing and Plant Analysis
Crop Science Society of America
Poultry Science Association
Rural Sociology Society
Society of Nematologists
Soil Science Society of America
Southern Weed Science Society
Weed Science Society of America

The objective stated in the Bylaws is "to advance the understanding and use of agricultural science and technology in the public interest, such to be accomplished by (*a*) coordinating the efforts of scientific agricultural societies to provide information to the government and the public for solution of problems of national and international concern, (*b*) improving communication and promoting unity among the various branches of agricultural science and technology, and (*c*) cooperating with organizations representing other sciences on matters of common interest." In the past three years, tight food supplies and the energy situation have added to environmental protection and food safety as prominent sources of concern to which CAST might respond.

CAST has a 501(c)(3) classification (tax-exempt) with the Internal Revenue Service and is classed as a public foundation.

Organization and Financing of CAST

CAST has four classes of members. First are scientific societies. Second are individual members—persons interested in the objectives of CAST. Third are supporting members—nonsociety organizations making a major contribution to the support of CAST (in practice, industrial corporations related to agriculture). Fourth are sustaining members—those not qualifying for the other classes (in practice, mostly trade associations paying smaller dues than supporting members pay).

Annual dues for societies range from \$1.00 per member for small societies to \$5,000 per society for the largest.[1] Individual members pay \$10. Supporting members pay \$200 to \$5,000, depending on sales

[1] Annual dues for societies having 3,001 to 4,000 members are \$3,000 and for those in the 4,001 to 5,000 bracket are \$3,750. AAEA's membership in 1973 was about 4,000. "Members" means regular members, domestic and foreign, paying full dues.

of agricultural products or of products used in agriculture. Dues of sustaining members are $50 for state or regional groups and $100 for national groups. In the year ended September 30, 1974, receipts of annual dues amounted to $20,748 from societies, $10,550 from individuals, $58,700 from supporting members, and $1,250 from sustaining members.

CAST's Board of Directors consists of (*a*) director-representatives named by societies (one to three per society, depending on the society's size, (*b*) directors (currently two) elected by individual members, and (*c*) the president, president-elect, immediate past president, and executive vice president (the latter nonvoting). Supporting and sustaining members are not represented as such. However, each supporting member nominates two persons for individual membership and each sustaining member nominates one, and these individuals are eligible for election to the Board as representatives of individual members. The Executive Committee consists of the four officers and four other Board members. All are elected by the Board; all except the executive vice president are elected from the Board. A Board member serving on the executive committee no longer is regarded as a society representative and is replaced on the Board by a newly appointed representative.

The executive vice president is in charge of day-to-day operations and serves as secretary and treasurer. The current executive vice president is Charles A. Black, Distinguished Professor of Agriculture in the Agronomy Department at Iowa State University, first president of CAST and a leading figure in initiating CAST. His office is headquarters of CAST, and the only other employee keeps records and does other chores. An Agronomy Department secretary supplies typing help. CAST has been heavily dependent on Black's energy and initiative and on the Agronomy Department's hospitality. As CAST realizes, it must go to a more self-supporting and sustainable means of operating.

CAST's income in the year ending September 30, 1974 was $100,588.38, of which $91,248.00 was dues as already described. Gifts and grants amounted to $6,247.69. Total expenditures were $49,140.85, of which travel (mainly by task force members) was $22,586.81; printing was $10,810.32. The excess of income over expenditure makes possible a more self-supporting operation.

CAST's Activities

CAST's principal activity consists of task forces set up to make quick studies of and to report on such specific questions as effluent guidelines for feedlots, use of DDT to control tussock moth, livestock grazing on federal lands, impact of an international food bank, and rural transportation needs. Most requests for such studies originate with Congress or government agencies, but CAST itself originates some studies. Each task force consists of professionals whose skills contribute to understanding the problem at hand. A task force is expected to assemble, analyze, and interpret data already available rather than to undertake new research; timely application of existing knowledge to recognized problems is the main objective.

Task force reports are intended to be objective and factual. They are expected to point out alternatives and their probable consequences. Recommendations are not made. Task forces write their own reports, but the reports are reviewed for conformance with these principles and for editorial acceptability. Statements associating CAST or member societies with any public policy or position are avoided. CAST now pays travel expenses of task force members if the member has no other source of reimbursement, but some early task forces did not receive such support. A list of CAST documents, issued in January 1975, showed forty-two reports completed or in process.

A lesser activity of CAST consists of special projects launched on its own initiative. One is preparation of a *Directory of Environmental Scientists in Agriculture*. Another was the *Pesticide Report to the Nation*. On one occasion, CAST was asked to supply names of experts in a specialized field, and two persons on the list were invited directly to testify at hearings. CAST's policy at this stage is to remain flexible in methods of responding to needs as they appear.

A large proportion of CAST's task force topics have involved economics, and about twenty-five task forces appointed prior to January 1975 had one or more agricultural economists among their members. Some were chaired by agricultural economists. (In a few instances, agricultural economists listed as serving on task forces had not done so; apparently, the mix-up was due to not correcting preliminary lists in responding to this committee's request for information about task forces)..

Tentative Evaluation

Members of this committee consulted with colleagues in agricultural economics and in other fields and with a diversity of other persons who might be knowledgeable about CAST. C. A. Black promptly supplied all information requested by the committee. A principal source of information was a questionnaire sent to agricultural economists who had served on CAST task forces. It was expected that these persons would be informed about CAST and would have useful firsthand impressions about task force operations. Results lending themselves to simple tabulation are given in tables 2 and 3.

It is apparent that a major element in the image held of CAST both among agricultural economists and others outside of CAST is the extent to which

Editors of the *American Journal of Agricultural Economics*

L. A. Moorhouse	Office of Farm Management, USDA	Vols. 1–3	1919–1921
O. C. Stine	Bureau of Agricultural Economics, USDA	4–6	1922–1924
E. G. Nourse	Institute of Economics Brookings Institution	7–8	1925–1926
H. R. Tolley	Bureau of Agricultural Economics, USDA	9–11	1927–1929
H. E. Erdman	University of California-Berkeley	12–14	1930–1932
O. B. Jesness	University of Minnesota	15–17	1933–1935
H. C. M. Case	University of Illinois	18–19	1936–1937
T. W. Schultz	Iowa State University	20–23	1938–1941
H. B. Price	University of Kentucky	24–25	1942–1943
Warren C. Waite	University of Minnesota	26–30	1944–1948
Walter W. Wilcox	Library of Congress	31–33	1949–1951
Lawrence W. Witt	Michigan State University	34–36	1952–1954
Harold G. Halcrow	University of Connecticut	37–39	1955–1957
Robert L. Clodius	University of Wisconsin	40–41	1958–1959
Herman M. Southworth	Pennsylvania State University	42–44	1960–1962
James Nielson	Michigan State University	45–47	1963–1965
Earl R. Swanson	University of Illinois	48–50	1966–1968
Varden Fuller	University of California Berkeley (1969) Davis (1970–71)	51–53	1969–1971
Leo Polopolus	University of Florida	54–55	1972–1973
Max R. Langham and Leo Polopolus, coeditors	University of Florida	55–56	1973–1974
William G. Tomek	Cornell University	57	1975–

American Agricultural Economics Association

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B. F. Stanton, Cornell University

10 Aug 1976

Objective

The AAEA seeks to further the systematic development of knowledge of agricultural economics in order to improve agriculture and agriculture's contribution to the general economy. The activities of the AAEA include:

—publishing the *American Journal of Agricultural Economics;*
—planning and conducting two annual meetings of the membership;
—sponsoring annual awards for outstanding extension programs, distinguished teaching, and outstanding research;
—recognizing outstanding agricultural economists through a fellows program;
—supporting a literature retrieval system in cooperation with the U.S. Department of Agriculture;
—publishing periodically a biographical directory of the AAEA's members;
—supporting an employment registry for agricultural economists in cooperation with the U.S. Department of Labor.

Membership and Subscriptions

Membership in the AAEA is open to persons having a professional interest in agricultural economics. Dues, payable at the beginning of each calendar year, are as follows: regular membership, $15, and junior membership for students, $5. Students applying for junior membership should use application forms available from and signed by the head of the department in which they are studying; junior membership is limited to three years.

Members of the AAEA receive this *Journal* as part of their membership. The institutional and nonmember subscription rate is $25 per year; individual issues are $5.

Payment of membership dues, correspondence regarding subscriptions, orders for individual copies of the *Journal,* changes in address, or inquiries about the general affairs of the AAEA should be addressed to John C. Redman, Secretary-Treasurer, American Agricultural Economics Association, Department of Agricultural Economics, University of Kentucky, Lexington, Kentucky 40506.